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The Chicago Drainage Board has determined to select three expert engineers of national reputation to act with the Chief Engineer as a permanent Consulting Board. These engineers will, among other things, determine the disposal of flood-waters from the areas which materially effect or modify the sanitary condition of the district; supplementary works, especially the exclusion of sewage from the lake, and the proper sanitation of the North Branch, and the works and inlets necessary to furnish the main drainage channel with water from the lake, and the works and treatment needed between the town end of Section 14, above Lockport, and Joliet. It is to be distinctly understood that the experts are to act with the Chief Engineer as Consulting Engineers. Any rules of the Board regarding the employment of experts which may actually or apparently conflict with this recommendation are to be rescinded.

Inspector-General Dumont, of the U. S. Steamboat Inspection Service, reports to the Secretary of the Treasury that the number of persons carried on steamboats last year was 6,650,000,000. The number of lives lost was 200, or 138 less than in the previous year. Of the lives lost only 48 were passengers, the remainder was made up of officers and crews.

The Carpenter Steel Co., of Reading, Pa., has submitted to the U. S. Navy Department the result of experiments and the testimony of steel experts, going to prove that after only two years' experience this American company is now making armor-piercing projectiles equal to the best Holtzer shells, heretofore the best in the world. The company expects, by utilizing the Harvey process, to still further improve its projectiles.

The intramural railway at the World's Columbian Exposition, described and illustrated in our issue of Oct. 13 and 20, is progressing rapidly. All of the foundations are in, and about 2¼ miles of the superstructure erected and ready to receive the iron, including the loop at the south end of the grounds. A traveling crane with two booms is at work raising the steel girders, which weigh about 60 lbs. per ft., and as soon as they are in position the ties and rails will be laid. The girders and rails are being furnished by the Illinois Steel Co., of Chicago. About 325 men are employed at present and the work is to be pushed to completion as rapidly as possible. The contractors are Remington & Co., of Chicago, and Mr. Carver Remington and Mr. J. Brown are in charge of the construction work.

A scraper for cleaning the water supply conduit of the water-works at Halifax, N. S., lodged in the high service main Nov. 3 and cut off the water supply from a part of the city for about three days. The scraper was invented and patented by Mr. E. H. Keating, M. Am. Soc. C. E., formerly City Engineer of Halifax, and was first used in 1880. It is said that the scraper consists of eight pieces of spring steel arranged to play over the inequalities of the interior of the pipe and loosen rust or other adhering particles. Behind the pieces are two circular sections of iron fitted with leather rims to make a fairly close contact with the pipe. Water having been drawn from the pipe to be cleaned the scraper is inserted, after which water is admitted behind it and the scraper is forced along by the pressure. On the above date the scraper lodged in a 20-in. section of the pipe, and the pipe had to be cut. In all about three days were consumed in finding and dislodging the scraper. After dislodging, it is said that another scraper was passed through seven miles of 15-in. pipe in less than two hours. Scrapers are used in Halifax in pipe down to 6 ins. in size. We are indebted to Mr. Henry Torrey, C. E., of Montclair, N. J., for the above information.

The turret-plates for the U. S. warship "Terror" have been shipped from the Bethlehem Iron Works to the Brooklyn Navy Yard. This ship is a cruiser with comparatively light side armor and two revolving turrets. Each turret is made of five plates, four of which are 11½ ins. thick and the fifth, or port-plate, is 12½ ins. thick. The plates shipped are from 14 to 16 ft. 5 ins. long and 6 ft. 2 ins. high, and the whole weight of the turret is 219,000 lbs. When set up the turret is 22 ft. 5⅝ ins. in inside diameter. There is a base plate on which the turret revolves and the roof is a low cone, 7 ft. 2 ins. high in the center. Each turret will contain two 10-in. guns.

The most serious railway accident of the week was a rear collision between freight trains, Nov. 20, on the Belt Railroad of Chicago, near the Archer Ave. crossing of the Chicago & Alton R. R. A local freight train had stopped for the crossing and was run into by a following train. Three men were killed and two injured.—A construction train on the Ottawa & Gatineau Valley Ry. was derailed on the approach to a trestle near Farrelton, Que., Nov. 16, and went down a high bank. Four men were killed.

A cave-in occurred in a tunnel on the Cincinnati Southern R. R., between Chattanooga and Harriman, Tenn., Nov. 14. An accommodation train was caught by the cave-in, but the men managed to crawl over the debris.

An explosion of 25 kegs of gunpowder occurred in a coal mine near Colliers, W. Va., Nov. 21, by which three or four men were killed and nine injured, two of them fatally.

Seven new ships of the United States Navy will be put into commission within the next three months. These include the "Machias" and "Castine," small gunboats; the "Monterey," a coast-defence monitor; the "Detroit" and Montgomery," cruisers; the armored cruiser "New York," and the "Bancroft," a practice ship for naval cadets.

The heaviest armor-plates yet placed on an American war-ship are those just secured to the sides of the "Indiana," now building at the Cramp shipyard, in Philadelphia. These plates are made of nickel steel, are 14 ins. thick, 6 ft. high and 16 ft. long, and weigh 26 tons each. The side armor of this ship will be 18 ins. thick, and each plate will weigh 46 tons. The first named plates were forged at the shops of the Bethlehem Ironworks, and they cost $15,600 each. Diagonal plates of the same thickness as those just put on the "Indiana" have also been shipped from Bethlehem for the sister ship "Massachusetts."

A bridge accident at Terre Haute, Ind., in which a span gave way owing to a head collision between a running and a standing freight train on the structure, was noted in our issue of Nov. 10, and we are indebted to Mr. A. G. Wells, Superintendent of the St. Louis Division of the Cleveland, Cincinnati, Chicago & St. Louis Ry., for the following particulars. The bridge was of iron, with three truss spans of 122 ft. 2½ ins., one of 150 ft., a drawspan of 155 ft., and a girder span of 50 ft. Three spans were built in 1881-82, the draw in 1885, and one span and the girder in 1886. The cause of the accident was a collision between two freight trains in the middle of the middle span, 122 ft. 2½ ins., and the span broke in two. There was no evidence of prior derailment. The bridge span, both engines and eight cars were a total loss.

The net earnings of railways in the United States show only indifferent results in comparison with the earnings for the corresponding month of last year, according to figures collected by the "Financial Chronicle." Returns from 127 railways show net earnings aggregating $24,902,163, an increase of 0.95% over similar earnings for September, 1891. The reasons for this showing are obvious and on the surface. While the grain movement as a whole in that month of this year was a great deal heavier than for the same month of 1891, the movement of spring wheat in certain sections of the Northwest fell below that of a year ago, and as a consequence some of the roads in that section suffered a loss in earnings. In the South there was a heavy falling off in the cotton movement. Then also the tendency toward augmented expenses has again been an important factor in affecting net results, though in some cases there has been a modification of that tendency, and in a few special instances an absolute reversal of it. Finally, the comparison is with very good earnings last year, September then having yielded exceptionally favorable results.

The location of the new East River bridge has been approved by the War Department and the height fixed at 145 ft. at the center and 120 ft. at the piers. The bridge company has submitted an amended petition to the New York Aldermen, defining the location proposed and asking permission to extend their railway on an elevated structure across the city from the East to the North River, and connecting with all existing elevated railways in New York and Brooklyn.

Test borings for the Prince Edward Island tunnel, across the Northumberland Straits, have been made by Mr. Alfred Palmer, C. E., of New York. The boring is carried on in a tideway with a current of four miles an hour, and subjected to storms. An engine is mounted on a platform on the top of a 4-in. pipe in 20 ft. lengths, which rests at the bottom of the Straits, the pipe being trussed to prevent bending, and being supported by guy ropes attached to heavy anchors. The boiler is carried on a decked scow or pontoon, and has flexible connections with the engine, which drives a diamond drill at a very high speed. The drill cuts cylindrical cores. The line followed is between capes Tormentine and Traverse, the distance being about eight miles. The test holes are bored 1,500 ft. apart, penetrating a carboniferous sandstone, and showing that the soft, red clay shales and red sandstones of the Lower Permian are continuous across the Straits. The material met with is very favorable to the tunnel work. This contract is being carried out under the direction of the Dominion government, represented by the Hon. Geo. E. Foster, Minister of Finance, Mr. Collingwood Schrieber, Chief Engineer, and Sir Douglas Fox, Consulting Engineer, of London, England. The work is expected to be completed in about two months. A rough estimate of the cost of the tunnel is $7,000,000.

The United States navy yards need repairs and extensions, and the commandants of the several yards ask for $6,500,000 for this purpose. The Chief of the Bureau of Yards and Docks, Commodore N. H. Farquhar, reduces this demand to $2,250,000, limiting the expenditure for "improvements" to $1,187,000. This amount covers two new docks, one at Boston and another at Portsmouth. The Chief also asks Congress that the corps of civil engineers in the navy be increased in number to 20 members. This number would include the assistants to be selected from graduates of the Naval Academy.

The only formal bid Nov. 21 for a new water supply for Jersey City was from Moffett, Hodgkins & Clarke, 16 William St., New York, who proposed to deliver a supply from the Rockaway River drainage area to the present Belleville receiving reservoir, on approximately the following terms:

First	22,000,000	gallons	daily	at	$40	per million gallons.
Next	3,000,000	"	"	"	38	" "
"	5,000,000	"	"	"	34	" "
"	5,000,000	"	"	"	31	" "
"	15,000,000	"	"	"	25	" "

Average for 50,000,000 gallons daily at $33.80 per million gallons.

For water delivered at the Bergen high service reservoir an additional charge of $8 per million gallons would be made.

An informal bid was made by Mr. Geo. B. Inman, C. E., 136 Liberty St., New York, who offered to supply water from Long Pond, Morris, Swartwood and Culver Lakes, in northern New Jersey, for $38.50 per million gallons for 5 years and $24.60 for the next 20 years. He also proposed, it is stated, to deliver the water-works to the city in fee simple at the end of 25 years provided $18.75 per million of gallons of water delivered were paid in addition to the above prices. The bid was not considered because the necessary deposit of $100,000 had not been made.

Mr. Garret E. Hobart, for the East Jersey Water Co., which built the supply works, recently completed for Newark, stated that his company was debarred from bidding by the terms of the specifications, but that it was willing to contract to deliver all water needed within six months at a lower rate than any other company. Mr. Hobart called attention to the clauses in the specifications providing that cast iron pipe must be used and making a gravity supply necessary, stating that these conditions would increase the cost of the works.

THE SPRAGUE-PRATT ELECTRIC ELEVATOR.

In the manufacture of elevators the United States not only leads the world, but is so far ahead of European nations that the best work which has been done abroad in the manufacture of "lifts" has been but a mere copying of American designs and devices. The safety, speed and economy of the best American elevators have made possible modern American office buildings, which in their turn have brought about a concentration of business and an easy and rapid intercomunication in the office building districts of the principal cities which was undreamed of a few years ago.

At present the hydraulic elevator is in nearly universal use for first-class high speed passenger service. Its safety, when properly installed and operated, is unquestioned; and speeds as high as are practicable can be obtained with it; but its first cost, the space occupied by its machinery, and the amount of attendance required, are such that builders of electrical machinery and of elevators have for some time been at work on systems of operating elevators by electrical power. Several such elevators have been designed and are now on the market. For nearly four years Mr. Frank J. Sprague, the President of the American Institute of Electrical Engineers, and well known by his work in electric railway development, has been engaged in the study of this problem in company with Mr. Chas. R. Pratt, M. E., The elevator plant which they have invented and which is now ready for the market is one of great interest mechanically as well as electrically, for some wholly new problems have been solved in its design. A description of the elevator by its inventors, illustrated by half tone cuts from photographs, appeared in a recent issue of the "Electrical Engineer"; and by the courtesy of that journal we reproduce herewith cuts showing a general view of the elevator and of some of its details.

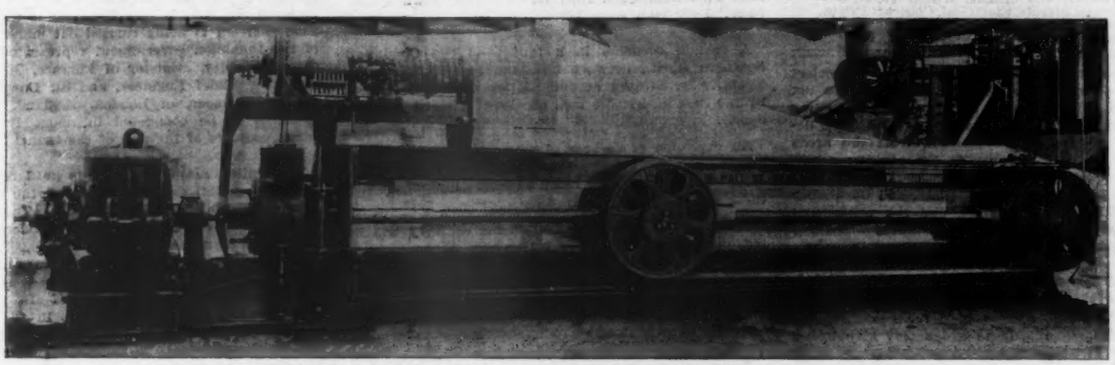


FIG. 1. GENERAL VIEW OF SPRAGUE-PRATT ELECTRIC ELEVATOR.

It will be seen at once that the inventors have departed widely from all previous practice in electric hoisting gear and have copied closely the general features of the hydraulic elevator. It is worth while considering briefly their reasons for this.

Practically all the hoisting machines now in use are of two types, in the first, the hoisting rope is wound around the drum. In the second, that used in the hydraulic elevator, the hoisting rope passes over a series of sheaves mounted in two pulley blocks one of which is stationary and the other movable. To raise the elevator car the movable sheave block is forced away from the stationary one, and a small amount of motion of this block gives a large travel to the hoisting rope. The principle is the same as that of the "block and fall" attached to an ordinary derrick or crane; but the power is applied at the reverse end, a pressure of several tons on the hydraulic plunger which pushes out the movable sheave block lifting in the elevator shaft a weight perhaps one-tenth or one-twelfth as great.

The advantages of this multiple-sheave type of machine over the winding drum type are chiefly in safety and smoothness of operation. There is no such thing as over-winding possible; there is no chance for the rope to wind on out of place or jump the drum flanges; the system lends itself readily to the multiple-rope system of suspension, while the drum system does not. Again, if the winding drum system is adopted, how shall it be driven? If by gearing, the jar from the successive contact of the teeth is transmitted to the elevator car. If by worm gearing, a limit is soon reached beyond which the speeds cannot be increased with out causing cutting of the worm.

These are, we believe, the principal reasons which have governed Messrs. Sprague and Pratt in their decision in favor of the multiple sheave type of machine as the one to which electricity should be adopted, notwithstanding the seemingly insuperable difficulties in the way.

Referring to the general view, Fig. 1, the Sprague-Pratt machine has for a main frame two horizontal guides between which moves a crosshead carrying a multiple-sheave block. A stationary block carrying a similar set of sheaves is mounted at the end of the guides. The elevator car is raised as in the hydraulic machine by separating these two sets of sheaves. In place of the piston rod which in the hydraulic machine pushes the movable block away, we have in this machine a long screw anchored at the left hand end, which pulls the movable block away from the fixed block. The electric motor is mounted directly upon the prolongation of this screw shaft and turns it without the intervention of any gearing. Evidently if the screw is made equally as strong as the piston rod of a hydraulic machine, there is no reason why this portion of the apparatus should not be as safe as the hydraulic.

But there are insurmountable objections to the use of an ordinary screw in this place. The force exerted against the threads of the screw is very great, perhaps 10 or 15 tons, and the nut must be moved along the screw at a rate of 30 to 40 ft. per minute or more, with a velocity of rubbing surfaces of over 1,000 ft. per minute. Even with the most perfect lubrication the friction of a screw is very large; and the proportion of power expended in friction is such that at the high speeds necessary, heating and cutting would begin at once.

We noted editorially in our issue of Nov. 10, advantages arising from the use of ball-bearings in certain classes of machinery. The Sprague-Pratt elevator is doubtless the most remarkable example of this advantage in existence, for it is by the use of ball-bearings between the threads of the screw and the threads of the sheave-carrying nut that the machine is made a mechanical success. In these days of many inventions it is never quite safe to say that a device is absolutely new, but the practically successful use of ball-bearings on a screw thread seem to have every probability of being an entirely new departure in mechanics.

It will doubtless occur to the reader that while in a circular ball-bearing the balls roll in an endless path, in rolling on the spiral of a screw thread the balls which enter at one end will pass through the whole length of the nut and emerge at the other. This difficulty was simply solved by connecting the rear end of the nut with the front end by a tube through which the balls pass, thus fulfilling the necessary condition of an endless path.

To give a more accurate idea of this ball-bearing nut: In an elevator now in service the screw is $3\frac{1}{8}$ ins. in diameter and has a thread with 1-in. pitch. The nut covers twelve threads and about 280 ½-in. balls are always rolling between the threads of the nut and screw. The speed of revolutions of the screw is such that 50 to 75 balls per second pass a given point, corresponding to a relative velocity of the screw thread surface over the nut thread of 250 to 375 ft. per minute.

With the large number of balls in service it will be seen that the pressure on each is very moderate. It is stated to vary from 50 to 125 lbs. The crushing strength of balls of two different makes was recently tested on a Fairbank's machine. In ten tests failure took place under pressures of 20,000 to 40,000 lbs.

It is evident enough that the use of electricity with the multiple-sheave type of elevator machine has been made possible only by the use of this ball-bearing; but the success attained here has led the inventors to a further use of this friction-saving system, and in every part of the machine from motor to elevator car, rolling friction has replaced sliding friction in transmitting the power. At the thrust bearing of the screw and the axles of the multiplying sheaves the saving in power thus effected is especially large. The friction of the whole machine is so little that a small weight on the hoisting ropes will run it backward, revolving the screw and its attached parts by the mere pressure of the multiplying sheave nut against the screw thread. The total efficiency of the whole machine, from the electric energy supplied to the motor to the work done on the elevator car, is about 50%. Mr. Sprague states that the hydraulic elevator has an efficiency of only about 25%, from the water in the pressure tanks to the car, and that the average pump used for supplying power to hydraulic elevators uses 60 to 70 lbs. of steam per HP. delivered to the pressure tank. On this basis he states that his elevator when using current from a central station can be operated with an expenditure of one-third the coal that is now used for a hydraulic plant of similar size.

Tests of a Knowles compound duplex steam pump supplying a plant of ten hydraulic elevators in the Redington Building, San Francisco, were recently made by Prof. Horace B. Gale, M. Am. Soc. M. E., and showed 23,234 ft.-lbs. of work done by the pump per pound of steam. This corresponds to 86 lbs. of steam per horse-power hour which is even a lower efficiency than that stated by Mr. Sprague. The loss of power between the pressure tank and the elevator car is very large, owing to the fact that the same amount of water at the same pressure must be used whether the car is full or empty, and the pressure must always be high enough to lift the heaviest load which the car carries.

But the saving in power is not the only advantage or the chief advantage claimed for the electric elevator. Bringing in power from outside makes unnecessary the placing of high-pressure boilers, always the source of more or less anxiety, close to the foundations of a great office building. The space saved by the boilers, pumps, coal and ash bins, etc., which are dispensed with, can be utilized to much greater advantage. It must be said on the

other hand that an electric service will be dependent on the current from the central station; and a fire there, or an interruption of the power circuit at any point, may oblige some hundreds of grumbling tenants to use the stairs until the damage can be repaired. It is fortunate, however, that the reliability of electric service is constantly increasing. Of course many large office buildings will have their own electric plant, as they require it for lighting in any event.

The saving in operating expenses will doubtless amount to much more in dollars and cents than the actual saving in coal. Mr. Sprague estimates the saving in operating expenses at ½ to ⅔. Great care has been taken to secure durability in all parts of the machine, and as far as the mechanical details are concerned it is apparent that the saving in friction by the use of the ball-bearings means also a saving in wear.

Referring again to the general view of the machine, Fig. 1, the motor is seen at the extreme left. Between it and the slides is a pulley fixed on the screw shaft and controlled by a steel and leather brake band, which firmly grips the pulley when the elevator is at rest. Above this brake is the regulating and controlling apparatus.

A detailed description of this would occupy more space than can be spared, but generally it consists of a pilot motor governed by the switch on the elevator car and a fireproof rheostat of ample size. To start upward the car switch is turned to the "up" position closing the circuit through the pilot motor. With automatic precision this little motor

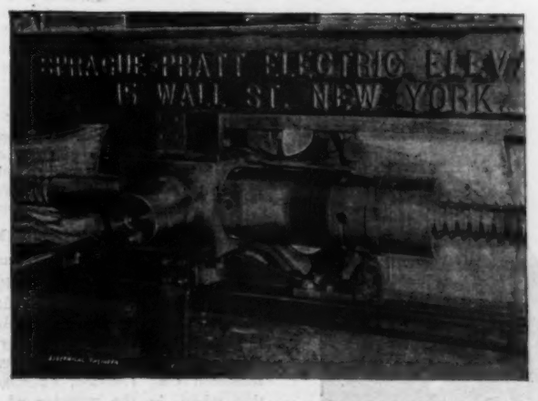


FIG. 2. BALL BEARING NUT OF SPRAGUE PRATT ELEVATOR.

first closes the circuit through the armature of the hoisting motor (the fields to which are independently excited) and then begins to cut out resistance on this circuit. As soon as enough resistance is cut out to give sufficient torque to prevent the car from running the armature backwards, the motor releases the brake from the screw shaft and continues to cut out resistance until it is all cut out and the hoisting motor is at full speed. The elevator boy can stop the pilot motor at any point and ascend at the diminished speed corresponding to the resistance in circuit.

To stop the ascent the car switch is turned to the central position. This closes the circuit in a reverse direction through to the pilot motor, which cuts in resistance to the armature circuit of the hoisting motor, applies the brake and opens the circuit.

To start down, the switch is moved to the "down" position. The pilot motor at once begins to release the brake and the screw is driven in a reverse direction by the weight of the car. This revolves the hoisting motor armature, which with its separately excited fields acts as a dynamo and sends a current through the rheostat. The gradual acceleration of the start is effected by releasing the brake gradually and by short-circuiting the hoisting motor armature at the start. As the speed increases the brake is thrown fully off and additional resistance is cut into the armature circuit, decreasing the dynamo brake resistance to the descending car. Thus while the time from rest to full speed in either direction is no greater than in any other elevators; a gradual acceleration is assured on a start either up or down. It is the sudden starting of elevators which makes their motion disagreeable. It should be noted that this gradual acceleration is made essential by the design of the machinery, and, while it can be adjusted to give a very quick or a very slow start, the elevator boy cannot start or stop with a jerk, no matter how quickly he may move the switch. Bad handling of hydraulic elevators is exceedingly common; but this machine ensures smooth riding with even the most careless elevator boy.

Considering finally the safety of the machine, the claim is made that it is safer even than the hydraulic. The multiple system of wire ropes now used on passenger elevators has such a great surplus of strength that accidents from breakage of ropes are unknown. The weakest point of the hoisting gear is the fastenings at the end of the ropes, and to raise the strength of these fastenings up to that of the ropes Mr. Sprague has discarded the common socket and uses instead a fastening with a double spiral groove. The rope is passed through a loop at one end, wound twice in one groove, passed through a loop at the other end and wound back in the other spiral groove, finally returning through the first loop. About 1½ ft. of rope is engaged by this fastening. A test with this fastening showed that a ⅞-in. iron wire rope broke at a strain of 10,500 lbs.

Taking up the safety devices proper, those placed on the car are the patterns which have best stood the test of service, but in addition there are other safety appliances peculiar to this machine. The centrifugal governor, which on other elevators is placed on the car, is here placed on the hoisting screw and applies the brake band to the pulley when the speed exceeds a desired limit. The hoisting screw is made of hardened and tempered steel, and has a factor of safety of 20, which is the factor of safety adopted for all parts of the elevator machine. The hoisting nut is also made of hardened steel and has shown almost no wear in a year's service. In addition to the hoisting nut is a safety nut attached to the former and with a female thread which is deeper than the thread of the hoisting nut and yet is normally out of contact with the screw. Should any accident occur to the hoisting nut, the safety nut immediately comes in contact with the screw and its friction is of course sufficient to stop any downward motion.

A safety appliance of still more importance is that which limits the travel of the car at the bottom and at the top of the shaft. It is not falling down the shaft which does the mischief, but the sudden stop at the bottom. There are two independent means of stopping the car at the bottom of its run. The first consists of a spring buffer built of rubber and steel, placed at the end of the screw. When the traveling nut comes against this it compresses it and acts as a brake to retard the turning of the screw. As the friction increases, the nut locks and revolves with the screw and the car is thus stopped without stopping the motor. In a recent test of this buffer a heavy car starting from the fifth story was allowed to fall freely down the shaft. The current supply was shut off so that the motor, although run backward, did not act as a dynamo, and the brake and other safety appliances were put out of service. The car quickly attained a speed of about 800 ft. per minute, the screw revolving at 1,200 revs., and then apparently ceased to accelerate. When moving at this speed the multiple-sheave cross-head came against the buffer, compressed it, and brought the car to rest in a distance of 18 ins., the passengers in the car being unaware that anything unusual had occured.

While the buffer forms an admirable safeguard against runaways of the car, a more gentle stop is of course desirable for regular use and this is effected by electrical means. When the car is within about 6 ft. of the bottom of the shaft the traveling sheave cross-head begins to cut out the resistance in the armature circuit and thus increase the power necessary to drive the motor backward. More and more resistance is cut out as the travel continues until the armature is short-circuited; and the speed is so reduced when the nut come against the buffer stop it only compresses it about ⅛-in..

The first of the Sprague-Pratt elevators was put in service in a five-story building on West 23d St., New York City, about a year ago, and, besides doing regular service, it has been subjected to the severest tests as regards safety, durability, etc., having even passed unharmed through a fire. A second machine was recently installed in the Grand Hotel at Broadway and 31st St., which has a double decked car 6 ft. square with a total weight of 2,300 lbs. The normal speed is about 250 ft. per minute, which can be readily altered to 450 ft. The elevator is soon to be on duty 24 hours per day, and it will be seen that the utmost reliability is essential as there is no other elevator in the building.

An important contract recently awarded to the Sprague-Pratt Electric Elevator Co. is for six elevators for the new Postal Telegraph building at Broadway and Murray Sts., New York. Four of the elevators are way and are to run at 325 ft. per minute with a live load of 2,500 lbs., and the other two are for express service at 400 ft. speed with 1,800 lbs. load. The building will be 14 stories high with elevator shafts 165 ft. deep.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Variance Between Public Contract and Precedent Advertisement.

Where a board of city trustees adopts a resolution of intention to construct a sewer along a portion of a street, but lets a contract for constructing the sewer along only a part of the portion specified in the resolution, the contract is void, and an assessment under the same creates no lien on property benefited. (McBean v. Reddich. Supr. Ct. Cal., 31 Pac. Rep., 7.)

Liability of Company for Unauthorized Acts of Employees.

Where the engineman of a railway company runs his train within the city limits, at a rate of speed forbidden by a city ordinance, the company is liable, though it had instructed the engineman not to so run his train, and had no knowledge of his act. (City of Hammond v. N. Y. C. & St. L. Ry. Co. Appel. Ct. Ind., 31 N. E. Rep., 817.)

Compensation for Right of Way in Missouri.

In an action against a railway for the appropriation of land for a right of way, the owner is entitled to recover the value of the land taken, and the damages, if any, to the tract of which it forms a part, estimated as of the date of taking possession, less the benefits peculiar to said tracts from the location of the road. (Ragan v. K. C. & S. E. R. Co. Supr. Ct. Mo., 20 S. W. Rep., 234.)

Conclusiveness of Engineers' Certificates.

A contract for building a sewer provided that the work should be done under the direction of the city engineer, that the plans to be given by him should be complied with, and that the return of the engineer should be the account by which the amount of work done and materials furnished should be computed. After the completion of the work under the supervision, and in compliance with the directions, of the engineer, he certified that it was satisfactory, and filed a final account showing the amount due the contractor; whereupon the council adopted a resolution declaring its intention to issue bonds to pay for the improvement, and, as assessment was made, and a portion collected. The issuance of the bonds, the payment to the contractor of the money collected, and the collection of the rest of the assessment, would be compelled by mandamus, though the sewer was defective, and did not comply with the contract and specifications in all respects; there being no allegation of fraudulent practice in the procuring and giving of the certificate. (People v. City of Syracuse. Supr. Ct. N. Y., 20 N. Y. Sup., 230.)

A railway on the east coast of Africa, extending 200 miles north of Delagoa Bay, through the Transvaal, is to be built by a company of French and Belgian capitalists. A contract for the construction and equipment of the line has been awarded to Westwood & Winby, Clement's Lane, London, for about $10,000,000. The engineers have already left England, and the railway is expected to be completed in two years.

THE BROWN SEGMENTAL WIRE-WOUND GUN.

Among the objects of interest which the members of the Institute of Mining Engineers examined in connection with the recent meeting at Reading, Pa., (Eng. News, Oct. 20), was the Brown segmental wire-wound gun, which was seen in process of construction at the works of the Pennsylvania Diamond Drill & Mfg. Co., at Birdsboro, Pa. It is a 5-in. breech-loading, high-power rifle, 19 ft. long constructed upon the system of Mr. J. H. Brown, the inventor, and under the engineering direction of Lieut. G. N. Whistler, Fifth U. S. Artillery, who is engineering the work for the U. S. Government, for which the experimental gun is being made. The following is an abstract of a paper presented at the meeting by Mr. N. B. Wittman:

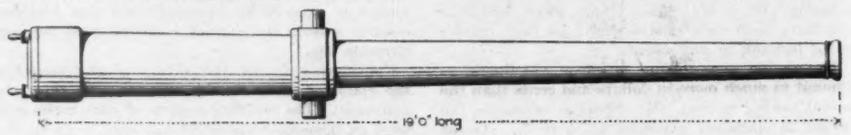
The system consists essentially of the subdivision of the inner core or tube of the gun, which takes up the initial compression, into longitudinal segments of such size that a higher physical condition and degree of special elasticity may be set up therein than it is possible to produce in the larger masses of metal heretofore used for the tube of the modern high-power cannon. The process consists in winding layers of square steel wire, subjected to a constant tension of 130,000 lbs. per sq. in., around these segments, which, when so held together, form the tube of the gun. A lining-tube may or may not be used.

The steel segments used in the gun now under construction are 18 ft. 4 ins. long, and 3 ins. thick at the breech, from which they taper to 0.8 in. at the muzzle. The physical condition of the segments has been determined by a test-piece, cut from each end of each segment, which showed the following characteristics: Tensile strength, 165,000 lbs. per sq. in.; elastic limit, 105,000 lbs. per sq. in.; elongation at rupture, 14% in 2 ins. They are of crucible chrome steel, made by the Carpenter Steel Works, Reading, Pa. The wire which holds them together has 0.005 sq. in. sectional area, and is wound under a constant tension of 650 lbs. on each strand, equivalent to 130,000 lbs. per sq. in. The winding has been done by a machine designed for the purpose by Mr. Brown. It consists essentially of a windlass and series of rollers, which act as a clutch, by which a weight is attached to the wire, and which is fitted with a friction brake, automatically regulating the speed of the passage of the wire through the machine. This speed being kept the same as that of the winding, the weight is thus held at a fixed height, insuring a constant and absolutely uniform tension upon the wire.

The wire used has the following physical qualities: Tensile strength, 250,000 lbs. per sq. in.; elastic limit, 200,000 lbs. per sq. in.; torsional strength, 30 full turns in 8 ins. before breaking. Following the curve of maximum pressure, the segments are wound at the breech with 33 layers of wire, making a total thickness at that place of 2.31 ins. of wire, and a layer is dropped at each 10 ins., so that there are but ten layers at the muzzle, giving at that point a thickness of 0.71 ins. Altogether, 3,256 lbs. of wire were used, equivalent to a single strand extending in a straight line 37 miles.

The wire was anchored at each end by a special device invented by Mr. Brown. As no flow of metal will occur below the elastic limit of the steel of which the segments are made, enlargement of the bore will not take place below a pressure of 94,000 lbs. per sq. in., which is 94% of the elastic limit, if that limit be taken at 100,000 lbs. per sq. in. (the minimum obtained from any one of the test pieces). As the pressure between the segments at the surface of the bore, induced by winding, is 100,000 lbs. per sq. in., it will require a powder pressure of 63,200 lbs. per sq. in. to reduce this compression to zero.

In order to demonstrate practically the truth of this proposition, a stub representing the powder chamber of the gun was made, and encased in a steel jacket, into the ends of which heavy plugs were screwed, entirely closing the powder chamber, with the exception of an aperture 0.2 in. diameter, to serve as a gas-vent and firing orifice. This has been fired repeatedly, with a charge which generated in all cases over 50,000, often over 60,000, and on four occasions over 63,000 lbs. per sq. in.; and in every instance without the slightest indications of displacement of the segments or enlargement of the bore.

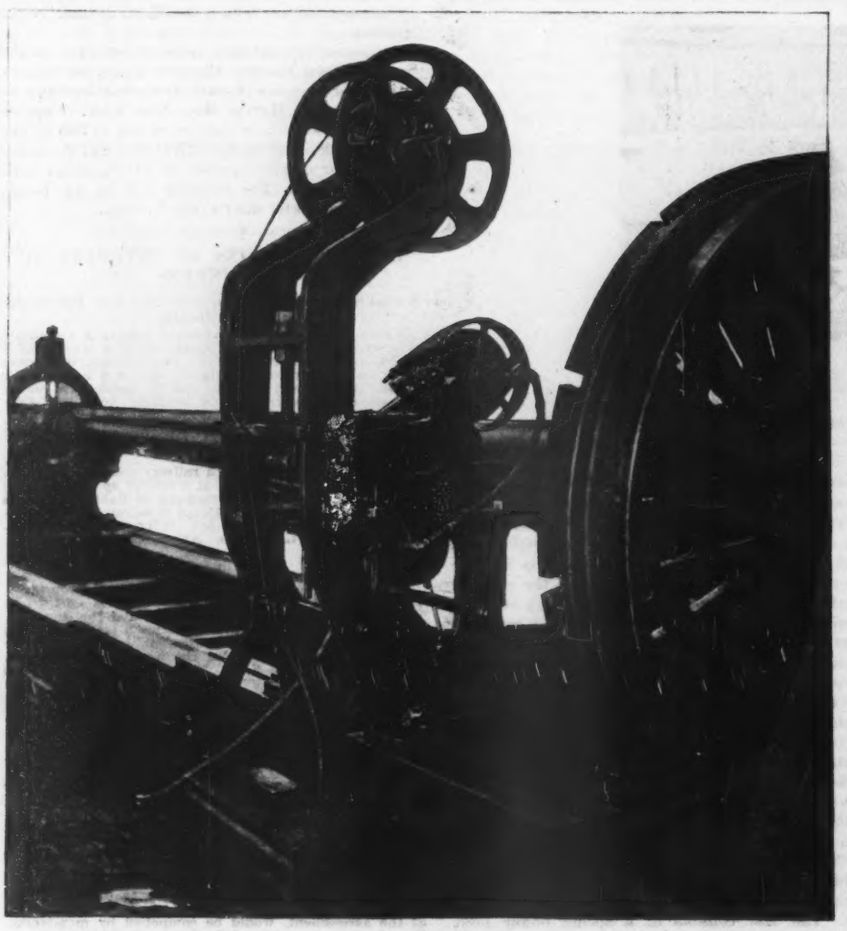


PLAN OF BROWN SEGMENTAL WIRE-WOUND GUN.

The trunnions are attached to a trunnion jacket, which is screwed to the breech of the gun. The major portion of the longitudinal thrust produced by firing is taken up by this jacket, and not by the inner tube. This is one of the special features of this system of construction. The chace of the gun, or that part in advance of the trunnions, is protected from the effect of small arms and machine gun fire by a steel jacket shrunk upon it.

The breech block presents some novel features, in the way of simplicity of design, and the maintenance of efficiency, in view of probable rough usage in actual service. A continuous thread is used, and, when the block is thrown open for charging, a latch locks it, so that it cannot be turned until it enters the breech. This insures proper centering of the threads under all circumstances, and a consequent minimum of wear.

The service charge of a gun of this size, made in the usual way, by shrinking steel hoops over a central tube, is limited to a powder pressure of 37,000 lbs. per sq. in.; while in this gun the ordinary charge will generate 50,000 lbs. pressure, and 60,000 lbs. per sq. in. can be reached with entire safety.



WIRE-WINDING MACHINE FOR THE BROWN SEGMENTAL WIRE-WOUND GUN.

AMERICAN TIN MINES.

By Stephen H. Emmens.

Dolcoath, in Cornwall, is, without question, the foremost tin mine of the world; and Capt. Josiah Thomas, its Superintendent, is, by common consent, the foremost living authority upon tin mines. Hence, the directors of the Harney Peak Tin Consolidated Co., Limited, exercised a wise discretion when, in the summer of the present year, they employed Captain Thomas to visit and report upon their tin mines in South Dakota.

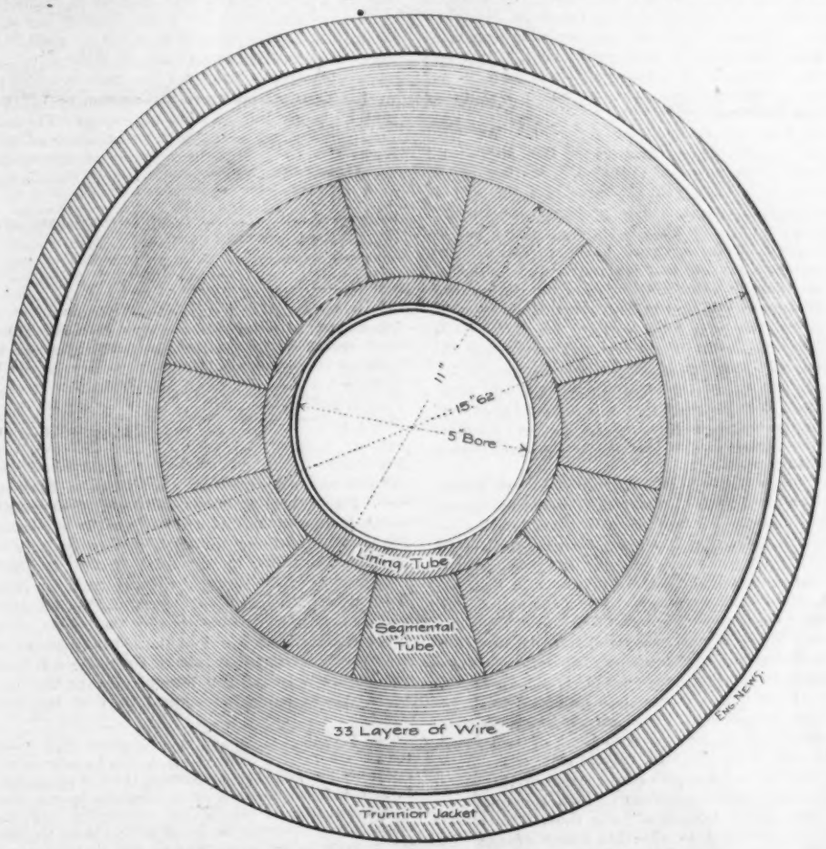
When I saw by the Cornish newspapers that Captain Thomas had returned to Dolcoath and was beginning to talk about his American experiences, I wrote to him, directing his attention to his utterances in this country, as reported by American journalists. I wrote at the same time to Lord Thurlow in much the same terms; and I did not hesitate to characterize the alleged utterances in question as "preposterous nonsense," taking for my text the following assertions printed in the "Black Hills Weekly Journal," of Rapid City, S. Dak., as a quotation from the "Scientific American," of New York, viz:

> This country, said Lord Thurlow, will not need to import any tin two years hence, for our mines will produce enough tin to last for centuries. The production will save $75,000,000 a year, which this country is paying for tinplate. This enormous sum will go in the hands of the people of this country. This company, of which I am the chairman, and in which New York or American capitalists are equally interested, has already built two of the largest and most thoroughly equipped mills in the world. Each has a capacity to produce 500 tons of tin a day, and this will be increased to 3,000 tons daily, should necessity demand it.
>
> Two or three other mills of similar proportions have been planned. We expect to begin to work the two mills already constructed by Oct. 1, and to put tin on the market in commercial quantities. I have inspected tin-making properties in various countries, but I never yet saw such resources as I found in South Dakota.

Captain Thomas at once replied to me saying:

> I was interviewed by several newspaper reporters in America, but I did not give any of them the least notion of what my opinion was of the tin deposits of South Dakota. I simply told them I was employed to make a report on the property by certain gentlemen, and should send my report to them. . . . I am not responsible for what Lord Thurlow said or is reported to have said. When you see my report on the property you can criticise it or make what remarks on it you please. I think it is about correct.

But as neither he nor Lord Thurlow could afford to allow the newspaper statements to which I had drawn their attention to go uncorrected, it was finally decided to make public the views they really entertained. Accordingly a general report on the properties of the Harney Peak company was prepared by Lord Thurlow and issued to the English press; and this has now been followed by the publication of the technical report made to the company by Captain Thomas, which may be summarized as follows:



CROSS-SECTION OF BROWN SEGMENTAL WIRE-WOUND GUN.

1. The company's mines consist of "about 1,100 claims, 1,500 ft. × 300 ft. each," extending "for a total length of about 30 miles in a somewhat circular form, for upward of three-fourth of the distance around Harney Peak." This peak "is composed of granite, in which rock no lodes have been yet discovered. The various lodes and ledges are in slates and schists surrounding the granite peak, and, generally speaking, are at about right angles to a line drawn from any point to the center thereof. . . . In almost all cases the lodes and ledges are either nearly vertical or DIPPING AWAY FROM THE GRANITE."

2. Two classes of deposits are observable, viz., "lodes" and "ledges." "The lodes are generally small but continuous, being from 1 ft. to 3 ft. wide, composed principally of quartz." They are, Capt. Thomas believes, "true fissure veins; but with few exceptions they are generally small, composed largely of quartz, and of little or no value—nor, in my opinion, are they ever likely to become sufficiently productive to pay for working. Large sums of money have been spent in procuring and working many of the claims in which these lodes are found, with no prospect of success. I understand that 150 men are at present employed in assessment work on the various claims in order to retain possession—at a cost, I presume, of about $3,000 per month—and I strongly advise that a large number of the claims be relinquished rather than spend any more money on them by way of trial or development. . . . I may here observe that if any lodes of fair size can be found dipping towards the granite instead of away from it, I should have a much better opinion of their being found productive. . . . The 'ledges' are for the most part large near the surface, but not continuous, and usually become much smaller in depth. They are mostly of a granite character, and contain large quantities of mica. Both lodes and ledges are very different in their character and composition from the tin lodes of Cornwall."

3. The detailed observations made at the various mines inspected are shown in the accompanying table.

4. The Etta mine, "is a very peculiar and irregular deposit, being in the form of a mountain, and having no defined direction or dip. A tunnel 160 ft. below the top was driven eastward through a mass of spodumene granite upward of 150 ft. wide, containing no tin of value, with patches of tin stone containing large quantities of mica. Some hundreds of tons broken from the whole mass, without selection, were put through the mill, and no wonder, therefore, that the result was so very unsatisfactory. . . . . The tin-producing portions occur only in patches, and are of so limited a quantity compared with the whole mass that I think it extremely doubtful if any profit can be made by the most careful working, unless the price of tin is very high. This deposit being of such great size and strength may, of course, improve in depth; but I cannot recommend any expensive trials to be made here at present."

5. "The pumping appliances hitherto used in the mines are very inefficient. They are more like toys than like machinery intended for serious work, and are only suitable for shallow workings, or for mere temporary purposes."

6. "The company's mill is capable of treating 250 tons of ore per day. The stock of ore already mined will, at that rate, be exhausted in less than two months." The whole of the ore hitherto discovered and ready for stoping in the Addie, Cowboy, Coates, Gertie and Tenderfoot, is equivalent to about 10 months' supply for the mill. But, in order to ensure this supply, stoping on a large scale should be commenced at once."

7. If the mill be operated at the rate of 7,671 tons (of 2,240 lbs.), monthly—or, 255.7 daily for 30 days—it may be expected to produce about 137 tons of "black tin" per month, containing 73%, or 100 tons metallic tin.

8. "In order to obtain a supply for the mill for the future, new ground must be opened up for working in other parts of the property without delay. There is, doubtless, a large amount of tin in the numerous claims owned by the company, but it is scattered over a very extensive area, and, so far as yet proved, the tin deposits are not only shallow, but are of no great length, thus making them costly to work, especially where shafts and pumping and hoisting machinery are necessary. . . . . By exercising care and caution, working the most productive lodes and ledges and avoiding those of low quality, I see no reason why an average yield of about 40 lbs. of black tin per ton (i. e., 1.3% of metallic tin, or 26 lbs. per ton of 2,000 lbs. of ore), may not be maintained for a long time to come, while there is an immense quantity of ground yet to be proved and developed, some of which may be of richer quality. The profits to be made will, of course, depend not only on the price of tin, but partly on the extent as well as the richness, of the deposits. It is easy to see that if a new shaft has to be sunk, and pumping and hoisting machinery erected for each separate deposit 150 ft. or 200 ft. in length, the cost of working such deposits will necessarily be considerable, and unless the ore is of a tolerably high grade they cannot be profitably worked. This fact should constantly be kept in view in the future working of the mines."

This report by Captain Thomas is, so far as the Harney Peak company's properties are concerned, an echo of an article* printed in Engineering News of Sept. 1, 1892, and containing among other things, the following remarks:

As regards the character, magnitude and probable future of the tin mines in the two districts (Harney Peak and Nigger Hill), it may be broadly stated that

Summary of Detailed Report of Capt. Evan Thomas on the Harney Peak Tin Mines.

Name of Mine.	Width of lode or ledge. ft.	Greatest depth of shafts. ft.	Percentage of metallic tin in sample from lode or ledge.	Opinion expressed by Capt. Thomas.
Ingersoll	30	.....	0.325	"Taken altogether, this ledge is of poor quality."
Black Diamond	7	30	1.105	"Probably a large quantity of tin ground."
Mountain Boy	.....	.....	0.845	"Principally composed of quartz of a hard and flinty character containing a little tin."
California	6	65	1.3	Lode not inspected.
Hopeful	2	100	.....	"Now idle. By no means of a promising character."
Evergreen	1	40	.....	"Too small and poor to warrant any further outlay."
Samaiias No. 3.	1½	100	0.975	"Water in shaft. Lode too small to be profitably worked."
" No. 4.	2 to 3	30	.....	"Principally hard quartz, with only a small quantity of tin which will not pay for extracting."
Ingersolia	.....	5	1.3	"Worthy of further exploration."
Addie	10 to 1 in.	600	1.43	"At the 300 ft. level, nothing that will pay to work. At the 400 ft. level, merely a wall. The ledge has not been seen below the 400 ft. level. The pumping machinery is very inefficient."
El Dorado	4	70	1.43	"The lode stuff is rather hard, but the indications are promising for continuance in depth."
February Group	70	200	0.4225	"Mine full of water. Cannot be worked to advantage."
Excelsior	4	100	1.3	"Full of water. Engine has been removed. Worthy of further trial."
Colossal	7	60	2.535	"Sample taken from the stuff that came out of the shaft."
Mewotinock	7	35	0.52	
White Whale	20	.....	1.9825	"Probably a large quantity of productive tin ground of more than average value."
Nevada No. 2	.....	200	1.04	"A very large ledge."
Cowboy	3 to a few ins.	300	1.2025	"Water in 300 ft. level. Pumping machinery out of order. Prospects for still deeper sinking are very encouraging."
Coates	8 to 2	400	0.585	"Ledge not seen below the 225. Will be found to be smaller at the deepest point."
Gertie	4 to 2½	400	2.21	"This lode, unlike many of the ledges, is improving in size and quality as depth is attained, and although the good tin ground is only about 120 ft. long, yet by continuing to drive on the course of the lode other paying shoots of tin may not improbably be discovered."
Butte	3	72	1.5875	"Water in shaft. Sample from heap near shaft."
Tin King	5	42	.....	"Of character and quality similar to Butte."
Dacon Wright	4	15	0.1625	"As a whole of inferior quality."
Naiad Queen	4	43	trace.	"Probably on same ledge as Dacon Wright."
Tenderfoot	8 to 2	300	1.0075	"For about 300 ft. in length the ledge is from 6 to 8 ft. wide; but the remainder is small and poor."
Tin Reef	15	46	1.625	"Water in mine. This ledge appears to be of great strength and considerable promise."
Flora	20	80	1.2675	"If the ledge continues its size as depth is attained, it will produce a large quantity of stuff."

the quantity of tin ore in the aggregate is very large and the quality very satisfactory. I have mined tin in Cornwall, and am familiar with the mines of that famous tin field. I do not, therefore, speak at random when I say there is a better show of tin in the Black Hills than in Cornwall. This, however, is very different from asserting the probability of any mines being developed in the Black Hills to rival the large tin mines of Cornwall. The geological features of the two countries are very different. The veins are unlike. A great dissimilarity is observable in the modes of occurrence of the cassiterite itself. Space does not admit of my entering into any detailed scientific discussion of these and many other features of difference; but I am quite sure that no expert miner, geologist or mineralogist who has personally inspected the tin mines of the Black Hills and Cornwall will care to place himself on record as seriously looking forward to the development of a Dolcoath in South Dakota. . . . . I naturally deduced two inferences: first, that in the opinion of Black Hills people, the sale of claims was decidedly more profitable than the working of them, and, secondly, that in the opinion of Black Hills people, grave doubts existed as to the continuous character of the ore deposits. Is this, indeed, the key to the whole mystery? There is, as I have already said, a magnificent show of tin in the Black Hills, and the aggregate quantity is very large. But I did not see and have not yet heard of any single mine in which any demonstration exists of considerable ore bodies. The famous Etta mine was a famous failure, and when I saw it in 1888, it was, to use the Cornish miner's phrase, "as poor as death." The cause of the stoppage of the mill was self-evident. . . . . In conclusion, let me state that I share the opinion of Professor Vincent, and, indeed, so far as I know, of every well-informed expert of sober judgment who has inspected and reported upon the tin mines of South Dakota, namely, that the mines in question are for the most part capable of moderate production, moderate profits if operated with skill and economy, and if aided by the establishment of reduction works at various centers.

The importance of this quotation lies in the proof it affords of no material progress or development of the Dakota tin mines having been effected between the date of my inspection in the spring of 1888 and the visit of Captain Thomas in the summer of the present year. He and I have, it is evident, both seen the same general facts, the same general conditions, the same ore deposits with a lack of continuous character, the same absence of any single mine with demonstrated considerable ore-bodies; and, of course, we have both arrived at the same general conclusions. And if any of the mines and works I saw outside the properties of the Harney Peak company had developed into success during the four years succeeding my visit, it is reasonable to suppose that they would have attracted the attention of Captain Thomas and would have been mentioned in his report for the encouragement of the directors who consulted him. Accordingly, it may be taken as a patent fact that four years of lavish expenditure, an ample supply of labor, machinery and materials, the efforts of an army of prospectors, the creative vim of American engineering and the tireless tooting of Western editors have failed to lay the foundations of a commercial output of Black Hills tin.

Under these circumstances the question arises whether any other tin-field of greater promise is as yet known in the United States, or whether American tin-plate manufacturers must rely upon imported tin for their raw material. Unfortunately, the facts of the case do not admit of a favorable reply.

A serious attempt has recently been made to exploit the tin deposits of King's Mountain, N. C. Cassiterite of fine quality was mined and a very large area of tin-bearing ground was opened up. But no ore-body of any magnitude was encountered, and the average yield was not sufficient to pay costs. In spite, therefore, of a favorable climate and exceptionally cheap labor, the enterprise was abandoned.

An equally serious attempt has, during the past year been made to develop the tin deposits of Southern California; and ingot tin from that source has actually entered the New York market. The mine is owned by an English company, the San Jacinto Estate, Limited, and at a meeting held in London on Oct. 28, a report was made by Mr. Vercoe who had just returned from an inspection of the property, and who said: "The vein has not been lost, only the workers have reached the bottom of the deposit of ore. The lode in which the tin is found is a true fissure vein, and according to all experiences there is no reason why a second deposit of tin should not be found in depth, indeed, I think it will, but as the mine stands at present there is very little ore in sight." It would seem, therefore, that the California mine is not more promising than those of South Dakota or North Carolina.

In Virginia, matters are different. At Irish Creek, on the western flank of the Blue Ridge, and within a few miles of Vesuvius, a station on the Shenandoah Valley R. R., there is a tin field of considerable extent. The principal development has taken place at what is known as the Cash tin mine; but owing to almost incessant litigation as to the title for the last six years, and to the inflated views of value held by all of the contestants, no systematic mining has been practicable. Enough, however, has been done to prove the existence of considerable bodies of tin ore; and seeing that the geological formation of the district is favorable for the occurrence of regular veins in congenial country-rock, it is probable that a permanently productive mine may ultimately be opened up. At present the deposit cannot be regarded as more than a favorable prospect.

No other tin field of importance as yet known in the United States. Stories of discoveries appear in the newspapers from time to time, but the alleged "finds" are apt to elude investigation. And even when reports and analyses are produced for the entertainment of private investors, a little investigation works wonders. For example, I was recently consulted by a world-renowned American artist with reference to a prodigious discovery of tin in Jefferson Co., Colorado. A report was shown me signed by "Geo. Archbold, M. D., P. L. D., F. C. S., London and Berlin, late Chief Chemist, U. S. Navy Department," who gravely set forth that the discovery in question consisted of two lodes 30 ft. and 50 ft. in width, respectively, with "hundreds of tons of float ore (black oxide of tin) scattered loose over the surface of both lodes and on the side of the mountain." He then, with equal gravity, proceeded to give his assay of the ore which, in addition to 12.22% of metallic tin, was announced to contain 0.42% of palladium! I ventured to "hint a doubt and hesitate dislike," and to suggest the putting of a few preliminary questions to the "expert" before incurring the expense of an inspection of the property. This resulted in the offer being suddenly withdrawn. "Ex uno disce omnes."

I do not say that no rich tin field exists in the United States. So far, indeed, am I from asserting this, that I venture to predict, partly from theoretical considerations, and partly from personal observation, that productive tin-mines will yet be found in Arizona, New Mexico and Colorado. But this opinion is quite consistent with a recognition of the fact that at present no commercial supply of American tin is in sight.

* "The Tin Mines of South Dakota," by Stephen H. Emmens.

RAPID TRANSIT IN LONDON.

An interesting article on the present and projected systems of rapid transit in London has recently been published in the "Quarterly Review," of London, pointing out the need of better facilities and showing that this need can be met by the construction of underground electric railways, several of which are now proposed, but showing also that the present tendency of city and government authorities to impose more and more onerous conditions may result in preventing capitalists from providing the funds necessary for the carrying out of the works. The article is anonymous, as are all the articles in this magazine, but it is understood to be from the pen of Mr. W. M. Acworth, the well known English writer on railway affairs.

The writer begins by a presentation of the question of railways and traffic. Within the area included by a circle of six miles radius, with Charing Cross as a center, there are 270 miles of line and 255 stations; and 400 miles and 391 stations within the area bounded by a circle of twelve miles radius. A large percentage of the lines and stations are used by more than one company, and consequently have the benefit of two or more independent services. If each station within the latter area was counted separately for each company using it the number would be increased from 391 to 659. The railways are of two classes: 1, those having a purely local traffic, such as the Metropolitan (underground), and, 2, the lines of the great companies having termini in London, whose proportion of local London traffic is difficult to estimate. The traffic of all the local lines is estimated at 158,000,000 passengers per annum, or 177,000,000, including the season-ticket traffic. The London traffic of the great lines is estimated at 150,000,000, or a gross railway total of 327,000,000 passengers. The total annual traffic is summarized as follows:

Railways	327,000,000	passengers.
Omnibuses	200,000,000	"
Street railways	200,000,000	"
Cabs and steamers	50,000,000	"
Total	777,000,000	"

This total divided by 4,250,000, the number of inhabitants of London, shows that each inhabitant only makes a journey in any public conveyance once in two days, or 183 journeys a year, while in New York the traffic on internal means of communication averages 243 per head per annum (Eng. News, Oct. 31, 1891). If the London underground railway system was used as much as the New York elevated railway system, it would carry 550,000,000 passengers per annum instead of 125,000,000. Particulars of these railways, their equipment, trains and traffic, will be found in our issues of May 2 and June 13, 1891, and particulars of the London traffic in our issue of Jan. 2, 1892. The growth of the elevated railway traffic in New York was discussed in our issues of Feb. 18, 1888 and Jan. 4, 1890. London is very far behind other large cities of the world in its street railways or tramways, having only about 100 miles of such surface railways. The street railways are not permitted to enter the central part of the city proper.

The foregoing facts and figures show that, large though the London traffic is, it is not by any means exceptionally large in proportion to the population. In fact, it is smaller than might naturally be expected, considering the wealth of the community and the magnitude of the area. In so far as this is so, we may set it down to the inadequacy of the existing means of conveyance. In the words of the recent report by the joint committee of the two Houses on electric railways, new lines "are required to relieve the overgrown passenger traffic along the chief thoroughfares, to provide for the natural expansion of London, and to check the congestion of our metropolitan population by facilitating cheap communication outward to a circumference which tends constantly to recede." Instances are not wanting to show how traffic increases as soon as facilities are provided for it. In New York, in the ten years following the opening of the elevated lines, the total movement in all directions increased from 169 millions to 371 millions, an increase of 120%. But of this increase only 45% was due to increase in the population.

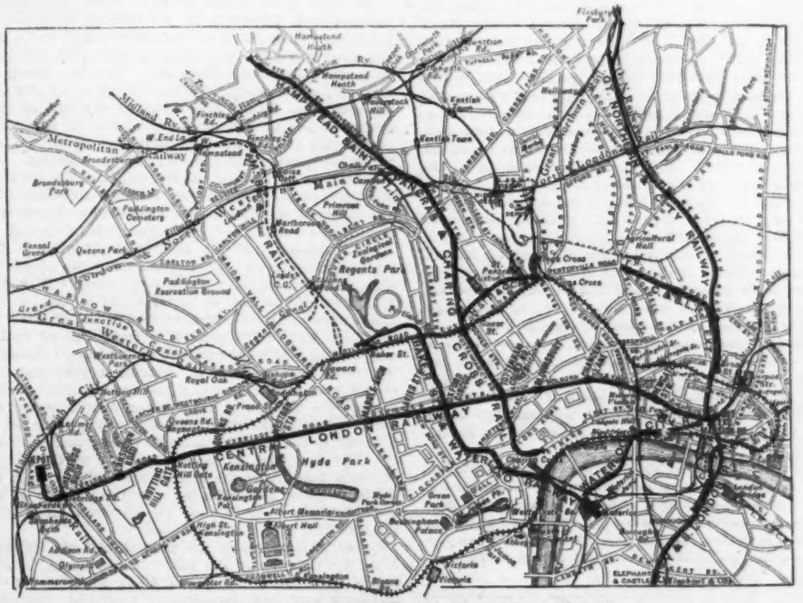
London has always been a very open city, a great part of its area being covered with small two-story workmen's houses, while it is far ahead of other cities in the number and size of its open spaces, and small as is the population per acre, it is decreasing rapidly in the central districts. The city proper had a sleeping population of 112,000 people 30 years ago, while now the number is only 37,000. But while the central area, with a population of about 1,000,000 showed a decrease of 7% in the decade ending 1891, the urban area outside the limits of the county of London, showed an increase of 49%, on top of a 50% increase for the previous decade. The clearing of overcrowded and unsanitary areas will also add to the growth of the outside population.

A further point, and an important one, needs to be noticed at this stage. The public conveyances of London carry about 2,500,000 passengers on an ordinary week day, and of this number the railways carry about 1,000,000. Spread evenly over the 24 hours this would be a manageable quantity enough, for the railway share of it could be accommadated without difficulty in 2,500 trains, while in fact the railway companies all taken together run something like 6,000 suburban and metropolitan trains a day, providing seating capacity for fully 2,500,000 passengers. But averages like this are only misleading. Into London in the morning the trains are crowded to the last seat, while outward they may have hardly a dozen passengers. Again, in the evening a train into Liverpool Street or

London Bridge will be all but empty, while the platforms of those stations are black and solid with passengers waiting to get back to their suburban homes. The city census shows that between 7 and 8 a. m. the number of persons entering the city was 57,000; between 8 and 9 it rose to 132,000, then fell slowly to 125,000 between 9 and 10; rapidly to 81,000, between 10 and 11, while finally, between 11 and noon, it dropped again to 67,000, or something like the normal figure for the daylight hours.

Rapidly as the business traffic of London is developing, it may be questioned whether the pleasure traffic is not growing even faster. To carry away even 20,000 people from a given point, at the conclusion of an entertainment, means working into the station empty, and working away filled to the last seat, 50 trains such as are commonly run on the underground lines. Assuming two lines to be available, the process can hardly take less than an hour and a quarter; and meanwhile, with platforms packed tight by an impatient crowd, any trifle, a match dropped unextinguished, or a disturbance created by a handful of lads, may have the most terrible consequences. Pleasure traffic as well as business traffic is rapidly increasing; and both come, not in a steady stream, flowing with constant force throughout the day, but in great spates, so that a means of communication may well be utterly overtaxed at certain hours, while on the average of the traffic over the whole day, and in both directions, it only seems to be carrying up to one-third of its capacity.

In discussing additional means of conveyance it is pointed out that omnibuses and horse cars are not of much avail for long distances and large areas, but no reference is made to cable and electric surface railways, both of which have been found very valuable for suburban traffic in this country. Elevated railways in the streets are out of the question in London, but overhead, narrow gage electric lines are suggested as practicable over some of the present main lines entering the city. Underground steam railways, similar to the Metropolitan and Metropolitan District lines are said to be commercially impossible on account of the expense involved in purchase of right of way and in construction, and these lines find their best returns from the long distance suburban passengers rather than from the short distance city passengers. The fares on these lines range according to the length of the journey. A mile of such railway is estimated to cost $5,000,000, and the operating expenses to be half the gross receipts. It is said therefore, that as far as the present position of engineering science goes, nothing but what is commonly known as the Greathead system is available for the extension of rapid transit in London. This is the system adopted on the City & South London electric railway, which has been described in our columns, and in the season of 1892 projects for six city and suburban lines on this system were put forward, all of which were reported upon favorably, but not authorized owing to the dissolution of Parliament before the bills were reached. The two Houses appointed a committee to consider the question as to whether underground railways worked by electricity or cable traction are calculated to afford sufficient accommodation for the present and probable future traffic. In evidence before this committee the city authorities and their engineers advocated the increase of diameter of the tunnels of the proposed lines from 11 ft. 6 ins. to 16 ft., increasing the cost of construction considerably, in order to admit of the passage of ordinary rolling stock, but the committee refused to accept these recommendations, thinking that traffic would be better served by a separate city service than by running through trains to and from the innumerable suburban points on the several main lines of railway. The passengers would therefore come into the various main line terminals and change to the underground railways, in the same way that New York passengers from northern suburban points come into the Grand Central Station on the main line suburban trains and there change to the elevated railway or surface cars to come down to the business portion of the city. The author does not believe in a uniform fare for local traffic in London, and says that it has been abandoned on the City & South London Ry., the uniform fare of 4 cts. being changed to 2, 4 and 6 cts., owing to the complaints of the short distance passengers.



MAP OF RAPID TRANSIT RAILWAYS FOR LONDON.

(Projected underground electric railways shown by heavy black lines, city lines of the existing underground railways by hatched line, and suburban and main lines of railway by light lines.)

Referring to the financial question and the provision of funds, the writer says that nobody who has taken an interest in the recent projects above referred to, can doubt the danger of scaring capitalists away from these undertakings, as the city and other authorities seek to impose all sorts of onerous and harassing conditions by special clauses in the bills. As an instance of this, the city authorities, in return for permission to the Central London Ry. Co. to open a staircase on the open space in front of the Royal Exchange, has imposed a statutory obligation upon the company to construct a system of subways connecting the sidewalks of the numerous streets centering at this busy spot, to be for the use of the general public and maintained, lighted, etc., by the company. The following extract from the evidence in favor of the projects, given before the committee by Sir Benjamin Baker, the well-known engineer, explains their position:

Every time you apply to Parliament, the parliamentary agents look through previous bills, and if they find an onerous clause they at once insert it in your bill. It may have been perfectly harmless in the bill in which it originated, but they are sure to ask it in yours, and then the promotors will not go on; they get sick and tired of it. I think everything is ripe now for a very rapid extension of these railways, provided one thing is kept carefully in mind, and that is the fact that we must be worked with in harmony by the public authorities. The public authorities never contend for a moment that these lines would not be of the greatest public advantage, and they are quite ready to pass any number of resolutions to that effect, but then, unfortunately, when they hand the thing over to their professional advisers, they too often, from an excessive zeal, attempt to lay down some general principles; general clauses which have simply the effect of rendering the whole thing impossible to carry out. I am quite certain that if that is avoided in the future, then we shall have a network of railways here; but if it be not, and if these prohibitory clauses are put in, unless the local bodies come forward and subscribe to the funds, the public financiers will not take them up; they will be dead letters. I need hardly say that it is clearly in the interest of the ratepayers, because, unless the traffic in the streets is relieved, new streets will have to be made at the expense of the ratepayers.

The writer having discussed the various points referring to the traffic and the means of providing for it, then sums up as follows:

The need for further rapid transit facilities is great and acknowledged. That need can be adequately met by the new system of underground electric railways, of which those at present proposed are, in the words of the joint committee, "a fairly satisfactory installment." The serious question is whether they can secure sufficient traffic at remunerative rates, and work it with sufficient economy, to pay interest on the necessary cost of construction. Probably the prospect of a moderate success is good enough to attract the investor, in whose heart hope springs up and blossoms luxuriantly if there be but the smallest patch of the hard ground of fact on which it can take root. Capital, however, will certainly not be forthcoming, if each new undertaking is to be exposed to conditions of construction and of working, more onerous than the last, still less if it is to be called on to carry a large proportion of its passengers at nominal fares, or to be threatened with the competition of rate-aided tramways. Therefore, seeing that railways alone can relieve the congestion of traffic in the streets and the overcrowding of the population in the central residential districts, it behooves the local authorities of the metropolis to act up to their professions, and to that bona fide promotors of new railway enterprise as allies to be helped and encouraged, rather than as objectionable intruders, whom it is a public service to keep at bay as long as may be, and a public duty to hold to ransom at the highest possible price.

The present projected underground electric railways are as follows, and the routes are shown on the accompanying maps: Central London Railway; Shepherd's Bush to Liverpool St. station, 6½ miles; authorized. City & South London Railway; extension from London Bridge to Pentonville Road, Islington, 2¾ miles; estimated cost of land and works, $3,500,000. Great Northern & City Railway; Moorgate St. to a junction with the suburban line of the Great Northern Ry. at Finsbury Park; 2½ miles, $6,000,000; this will have tunnels 16 ft. diameter to admit the Great Northern Ry. rolling stock for the suburban traffic which now runs over the crowded Metropolitan lines from Kings Cross to Moorgate St. Waterloo & Baker Street Railway, from Waterloo terminus of the London & Southwestern Ry. to Baker St., on the Metropolitan Ry., and the terminal station of the new main line into London, authorized to be built by the Manchester, Sheffield & Lincolnshire Ry.; 3 miles, $5,000,000. Waterloo & City Railway, from Waterloo terminus to the heart of the city, 1½ miles, $2,500,000, or $3,000,000 including hydraulic elevators and electric rolling stock. Charing Cross & City Ry., from Charing Cross station to Hampstead, a branch to the Euston, St. Pancras and Kings Cross terminal stations; cable traction is to be used on account of heavy grades, 5¼ miles, $6,250,000. All of these, it will be seen, are city lines, connecting the suburban lines of the several railways with the business centers; these suburban lines being considered sufficient, apparently, to distribute this traffic. A north and south line connecting the Kings Cross, St. Pancras and Euston terminal stations on the north, with the Charing Cross and Waterloo terminal stations on the south, has been needed and projected for many years, there being absolutely no public means of conveyance for the very heavy traffic across the city in this direction except omnibuses.

Particulars and drawings of the proposed underground electric railways for New York have been published in full in our issues of Oct. 10, 17, 24 and 31, 1891, and in another column of the present issue we give further particulars and drawings of these roads, the franchise for which is to be sold at auction in December.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XXXIII.

(Owing to the space required for the following communications, we give no further instalments of these articles in this issue.—Ed.)

THAYER SCHOOL OF CIVIL ENGINEERING, DARTMOUTH.

Sir: Knowing something of the labor involved in preparing your articles on the Engineering Schools of the United States, I will trouble you only with a brief note in relation to the statement concerning the Thayer School, which appears in the last issue of Engineering News.

We are not a mere post-graduate annex of the Chandler Scientific Department of Dartmouth, but entirely distinct, and on a separate foundation, as much as if in another locality. As a matter of fact, only 25% of our students have been graduates of the Chandler Scientific School, the others coming from four outside colleges, or from the classical course of Dartmouth College. Our building and equipment are entirely separate (we are about moving into a new building). We do not bid for members; in one respect we are on a more advanced plane than the medical college, in that we take only picked men, who must have had substantially a collegiate course in order to pass our examinations.

Respectfully yours,

Hanover, N. H., Nov. 14, 1892. Robert Fletcher.

(We realize the fact stated by our correspondent. The fact is that the Thayer School is somewhat "sui generis" among the engineering schools of the country, and we have not known exactly how to treat it. It is in some respects a mere post-graduate school, and therefore negligible within the scope of these articles; but in another respect it is practically an ordinary engineering school of the first class, which chooses to bother itself with the last two years of such a course only.

In any case we find we have done one serious injustice to the Thayer School, owing to confusion between it and the Chandler School. Prof. Fletcher sends us a list of seven of his graduates who are members or associate members of the Am. Soc. C. E. The total number of graduates from the school up to (and including) 1884 was 28. Therefore the Thayer School should have been credited with 25.0% in Table XXXII. in our last issue (p. 471) which brings it FOURTH in the list which follows Table XXXII., instead of fourteenth, and among the four schools which, so far as this test is a true one, appear to stand decidedly above the rest in the ability to train engineers to succeed. We shall make the proper correction in the reprint of these articles.—Ed.)

COURSES IN MINING ENGINEERING.

Sir: In my letter on the mining schools, published in your issue of Nov. 3, 1892, I devoted myself to the defense of the course of instruction and touched but lightly on the causes which have retarded the growth of these schools. "That they have not grown as rapidly as the other technical schools, and that there has been a falling off in the number of mining graduates since 1884, cannot be questioned.

We cannot, even if we wished to do so, shut our eyes to the facts brought out by your investigations. We can, however, fairly and logically differ from you in the interpretation of these facts. You insist that the cause of the small demand for the training offered at our mining schools must lie in the course of instruction. We maintain that it must be sought elsewhere. In this opinion we do not depend alone on our "inner consciousness," or our intimate knowledge of mining affairs, but we are sustained by the faculties of twenty or more mining schools here and abroad, and the host of mining men who have taken active part in the organization and development of these schools. We cannot all be wrong, and you alone right. (Why not? We and facts will take our chance against whatever "host of mining men."—Ed.). The course of instruction is practically the same everywhere. In some, less metallurgy, and in some a little more engineering. In none is there a complete separation of metallurgy from mining. In all schools of mining great stress is laid upon natural science, physics, chemistry, mineralogy, geology, etc.

You conclude your remarks with the question, "If it is not that, what is it?" Thus encouraged, I venture to address you a second letter, in which I shall try to answer your question:

1. In mining the force of circumstances does not compel the employment of engineers, as is the case in public works, and also in the manufacturing industries. All public works, railroads, canals, water-works, harbor improvements, etc., are executed by contractors, and engineers are necessary to obtain the data for these contracts; to draw up the specifications, and to supervise the work, and to see that the contracts are carried out. The shops make machinery for sale, and the maker that adheres to the old rule of thumb methods soon goes to the wall. Mechanical engineers and draftsmen are as necessary as machinists, foundrymen and blacksmiths. In mining, on the contrary, the contracts are small, and measurements made by the crude methods sanctioned by long established custom, are accepted without question. The quality of the product is but little affected by the method of working the mine, so that competition does not compel the employment of engineers as in the manufacturing industries. If the mine is rich, it will pay, however it may be managed; if poor, its poverty is accepted as sufficient reason for lack of success.

2. It is for this reason that there is a limited demand only for the services of the highly-trained graduates of our mining schools. The young mining graduate has to make a place for himself. He may find employment at the mines as a surveyor, a draftsman or an assayer; but, as stated in my last letter, "A few mine surveyors will make all the surface and underground surveys for a large mining district. Again, the work of construction is but an incident in the life of a mine, so that but few draftsmen and designers are required, and these chiefly by makers of mine machinery. As mine surveyors and as designers and draftsmen, the mining graduate comes into competition with civil and mechanical engineers, and with surveyors and mechanics of little or no scientific education. The demand is not large and the supply is unlimited. As mine surveyor, as draftsman, or as assayer, the graduate will have small chance of promotion, as these men have but little to do with the mine management."

The mine surveyor, for example, is rarely called upon to measure the excavations of the mine contractor, or to superintend in any way the work of excavation. The measurement of contracts is almost always done by the mine boss, by crude and imperfect methods, but by methods which have the authority of long usage, and are accepted by the miner and mine management. The underground contracts are let to small bodies of men, and mistakes one way or the other are not important, and tend to balance each other. In railroad work, on the contrary, as the contracts are large and important, accurate measurements are absolutely necessary, and the services of the engineer cannot be dispensed with.

Again, the mine surveyor is not necessarily called upon to give the lines for new work, either underground or on the surface, but this is frequently done by the mechanics themselves, by crude and laborious methods, it is true, but methods which answer the purpose, though wasteful of time, and therefore very expensive.

In the rare cases where such methods are inadequate; for example, in the transfer of property lines underground, or for the determination of the lines of gangways or shafts that have to be driven or sunk from several points at once; the services of the mine surveyor will be required to furnish the necessary points and lines, and, perhaps, once or twice to verify the work as it goes on. The superintendence of the work is always in the hands of the mine boss.

As a draftsman and designer, the connection of the engineer with actual mining operations is even more remote. He is chiefly employed by the manufacturer of mining machinery, or by the larger mining companies who make their own mine plant. His connection with the machine usually terminates when it goes underground, when the mine mechanic and the mine boss together superintend its installation.

The timbering of the mine, frequently presenting difficult engineering problems, is rarely trusted to the engineer. It must in all cases be planned underground, and can seldom be designed in the drafting room, or cut and fitted in the shop. In all cases it must be put in place by a skilled miner, and under the direction of the mine boss.

The line of promotion is thus cut off to all mining graduates unless in some way they can fit themselves for the position and work of an assistant mine boss, and take part in the superintendence of underground operations. To qualify himself to direct the work of expert miners the young graduate must become a miner himself. The importance of the work of the summer schools is thus evident, as starting the students in the right direction.

From what has been said it is clear that the demand for the services of the young graduate which exists in civil engineering, and to an even greater degree in mechanical engineering, is totally lacking in the profession of mining engineering. The young graduate in civil engineering is, or ought to be, a skilled surveyor. As such he finds immediate employment as transitman or leveler on the engineer corps of some new railroad. If faithful and diligent, he is likely to be in charge of a party before the work is done. If his training in the school has been thorough, he will probably be retained during the period of construction, which opens the way to a permanent connection with the road on the executive staff. In like manner the young graduate in mechanical engineering is, or should be, not only a good draftsman, but one to whom not merely the drafting of machinery, but also in part the design and superintendence of construction and erection may be entrusted. As draftsman he finds ready employment in the machine shop, and as designer and superintendent of construction, many lines of promotion and permanent employment are open to him.

3. We have in the above considerations ample explanation of the slow growth of the mining schools in this country. Those in charge of the mines are apparently content with the present order of things, and are slow to take advantage for their sons of the opportunities offered by the mining schools, and give but little encouragement to others to do so. The apathy of the mine official is well illustrated by a table compiled by the Director of the Houghton Mining School, in the Lake Superior region. This table shows that 18% only of the students are the sons of persons directly or indirectly interested in mining; 82% of the students come from other walks of life. There are signs of improvement, however. In the School of Mines, of Columbia College, 25% of the students now come from the mining regions, as compared with 10% ten years ago, and 7% twenty years ago. This percentage is, however, small compared with other lines of engineering education. In the Massachusetts Institute of Technology three-quarters of the students of mechanical engineering come from manufacturing towns, and only about one-quarter from Boston and its suburbs.

4. The small number of students coming from the mining regions, and the still smaller percentage who are the sons of mining men, is probably due in large measure to the lack of educational advantages in the mining regions, and by those most interested. The requirements for admission to our technical schools are high, and the tendency is to make them still higher. This view of the case is strengthened by the remarkable success of the Correspondence School of Mines, at Scranton, Pa., which requires a knowledge of reading and writing only on the part of its students, and begins its course with arithmetic. Started a year ago, this school now numbers over a thousand pupils. Such a school will awaken a demand for a still better and more complete education, and will undoubtedly act as a feeder to the regular schools of mining engineering.

5. The fact that so large a portion of the mining students come from the large cities and not from the mining regions also explains why the number of our students from year to year are so much affected by the condition of the mining industry.

6. The mining schools are undoubtedly still suffering from the collapse of the last "mining boom," which began about 1877, when the great bonanzas of the Comstock lode, and the mines at Leadville, discovered in 1873 and 1874, respectively, were in full production, which boom lasted until 1880. During this period, the entering classes at the mining schools were large and increasing in number, as is shown by the graduating classes of 1885 and previous years. During this period also, large numbers of new mining enterprises were inaugurated, and there was a great demand for mining experts and mining geologists to report upon mining properties. Eminent scientific men, geologists, paleontologists and chemists, with but little knowledge of mining matters, were pressed into this service, and naturally made mistakes. The blind and unreasoning faith in the scientific "professors," upon which so many mining companies were then floated, gave way to an equally profound distrust of the "scientific cuss." This feeling was strengthened by the exhaustion of the bonanza mines in 1880, and the falling off in a product of prominent Leadville mines a year or so later.

This depression in mining lasted until about two years ago, since which time a feeling of confidence in legitimate mining enterprises has been reviving, and the classes in the mining schools increasing.

7. The demand for mining engineers, again, cannot fairly be measured by the increase in the mineral production. A large part of this increased production comes from the natural development of a few large mines. An increase in production may even coincide with a decrease in the number of producing mines. In 1884 there were 30 mines producing copper in Michigan, and in 1890 there were 16 only. The product nevertheless increased nearly 50%. The bulk of our mineral

product comes from comparatively few mines. Thirty mines in Michigan, Montana and Arizona produce over 95% of all the copper. Out of 6,000 gold and silver mines reported on by the last census, there were but 179 mines producing $100,000 or over, and these few mines produced 75% of the total.

8. In view of the above facts the question suggests itself whether it is worth while to maintain expensive mining schools when there is so little demand for the instruction given. It seems to us that it is. The mineral resources of the country are enormous, and it is now the leading mining country of the world. Millions of dollars are invested in our mines, and their product is a most important factor in the wealth and power of the country. It is of the utmost importance that our mineral resources shall not be wasted, and that the development of our mines shall be skillfully and economically conducted. Thorough instruction in the art of mining is of especial importance to-day in view of the fact that our mines are becoming deeper, and that in the older mining regions the more accessible and easily worked deposits are being rapidly exhausted. The mining engineer to-day is brought face to face with the most difficult problems in mining. Greater skill and wider knowledge on the part of our mine managers is imperatively demanded. Our mining schools will have to supply the men to meet this demand.

Henry S. Munroe,
Professor of Mining.

School of Mines, Columbia College, Nov. 14, 1892.

(Our correspondent makes out a strong case. We admit, as we have before admitted, its abstract force. We earnestly hope it is as sound as it is plausible. Our opposite impressions were based only upon a count of noses in 1890. A new count in 1892-1900 may show, as our correspondent insists it will, that there is really nothing wrong to be corrected, except a temporary mental aberration in the choice of the vot—students, we should say—which time will bring about. Our wishes are wholly with our correspondent, but recent events have illustrated on a considerable scale that the cheerful conclusion "We know we are right. Therefore we have only to keep right on as before, only a little more so, and the public will come around to our view," is not always a safe line of reasoning. On the other hand, when the facts are as supposed, it is a safe line of reasoning, and leads to the expected result, as witness the rise of the same political party which has so recently been defeated. We subjoin still another communication on this subject, reaching similar conclusions from a different point of view, and with this we must leave the subject.—Ed.)

Sir: I have followed the article on "The Engineering Schools of the United States" with great interest, although I cannot agree with the conclusions formed as to why the mining schools are not holding their own with the other engineering courses. Where mining and metallurgy are the chief industries of the locality, and the young men and their parents are more or less familiar with both branches, as is the case here in Montana, we find that it is a very exceptional thing for a student to specialize either in engineering or chemistry, although at this institution they are free to do so, if they desire. The general impression is that their chances for securing employment and future advancement, are increased by taking the mixed course. In other words, there is little or no demand here for a purely engineering or a purely chemical course, even if mining be introduced in the engineering course or metallurgy be introduced in the chemical course. The table given in Article XXX., indicating that only 50.4% of the mining graduates of Columbia are following mining, while a larger percentage of civil engineering graduates from the Mass. Inst. Tech. are following their chosen profession, would hardly seem to indicate that the mining course is necessarily defective. The larger mining schools are situated in vicinities more or less remote from the mining regions. This fact renders it more difficult for the graduates, who are so disposed, to find employment in the mining regions, and the raw mining graduate resembles other raw graduates, in that he is not a specially useful member of the community until he has had a little outside experience. There certainly can be no comparison between the mining graduate after he has had a few years' experience, and the so-called practical man who has served the same time, and whose natural genius is no greater; yet we know that the man on the field always has an advantage, and this advantage possessed by the resident frequently debars the graduate from the position, especially when the resident is already more or less familiar with the property. Another point to be considered when drawing conclusions from statistics of mining courses, is that many in the East take the mining course with no intention of following mining, but rather with the idea of getting a good scientific training, which will at the same time aid them in determining their future line of work. The position of mine superintendent only too frequently means almost complete isolation from civilized society, and this is distasteful to most young men, especially those who have been brought up in cities, and many students have half finished their course before they realize that such is the case.

Until it is shown that the civil or mechanical graduates have practically replaced, or are replacing the educated mining engineers in their profession, I think that we are justified in taking exception to the statement that, "the civil or mechanical graduate will beat him on his own ground."

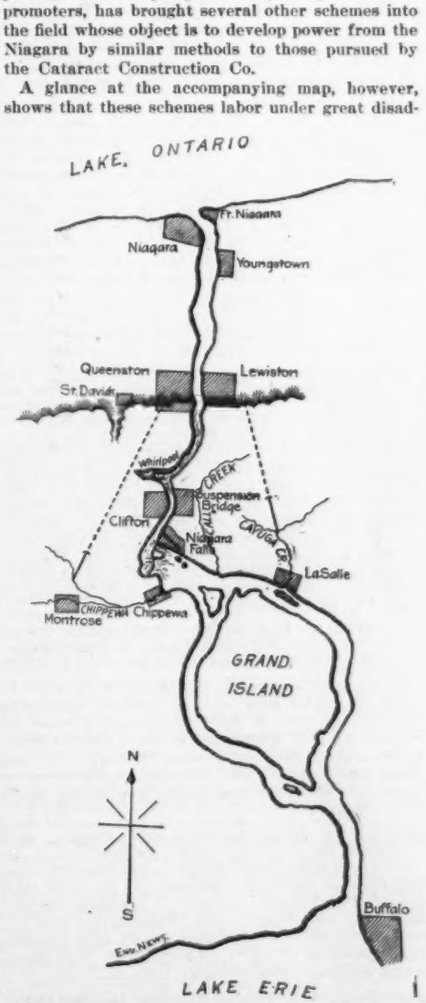
A. M. Ryon,
Professor of Engineering and Mining.

School of Mines, College of Montana.
Deer Lodge, Mont., Nov. 9, 1892.

PROJECTS FOR WATER-POWER DEVELOPMENT ABOUT NIAGARA FALLS.

The wide publicity which has attended the work of the Cataract Construction Co. in the development of a small portion of the Niagara Falls power, with the prospects of great profit to its promoters, has brought several other schemes into the field whose object is to develop power from the Niagara by similar methods to those pursued by the Cataract Construction Co.

A glance at the accompanying map, however, shows that these schemes labor under great disadvantages compared with the enterprise carried out by the Cataract Co., the length of tunnel required being far greater, and the necessary investment to develop a given power being, therefore, much increased.



Plan Showing Schemes for Water Power Development About Niagara Falls.

We are indebted to Mr. Thos. M. Griffith, of West Brighton, Staten Island, for the following account of surveys made by him some time ago to determine the practicability of a water-power development scheme at Queenstown, Ont. The report is especially interesting from its showing that the topography of the country prevents the conduction of water from the river about the falls to the face of the escarpment, some eight miles below, by any other means than tunneling.

The surveys which were made to determine the practicability of developing water power from the Niagara at Queenstown, a small village on the Canadian side of the Niagara gorge, some seven miles below the Falls, showed that a tunnel about seven miles long would be necessary. The promoters of the scheme proposed to take water from Montrose Creek, a tributary of the Chippewa River, which empties into the Niagara just above the rapids, and by dredging and deepening these streams a reverse current from the Niagara River could have been secured. It was thought by the promoters that it would be an easy matter to divert water from the Niagara through these natural channels and conduct it in an open canal through easily excavated material to Queenstown. It was asserted that an ancient Niagara gorge had been discovered, now filled with drift, extending from a point above the Falls to St. Davids, three miles west of Queenstown, which would greatly facilitate the excavation. The survey, however, showed little evidence of such a formation. An examination showed that there were no depressions where a canal could be located. A line was selected as the best available which permitted an open channel for a short distance at each end, and levels were taken along it. Taking as datum the surface of the river at Queenstown, the elevations are as follows: General elevation of village of Queenstown, 120 ft.; top of escarpment, south of Queenstown, 360 ft.; water surface in Chippewa River, 320 ft.; highest point on line (Lundy's Lane), 429.5 ft.; average elevation of surface along that part of the line where tunneling would be necessary, 350 ft.

The geological formation is remarkably regular, and, although borings were not made, the tunnel would probably be located in the shales and limestones throughout, except in case the ancient gorge above alluded to is shown to exist.

The accompanying map shows the lines surveyed by Mr. Griffith and gives an idea of the topography of the country. It will be seen that the escarpment above referred to extends at right angles to the gorge for a considerable distance on each side. A similar scheme to that above described has been agitated at Lewiston, on the American side, opposite Queenstown. Water could be taken from Cayuga Creek, and the length of tunnel which would be necessary is only about four miles. Besides the development of power, it is proposed to utilize part of the flow through the tunnel for irrigation purposes, and it is believed that large tracts of land in the vicinity of Lewiston can be much increased in value in this way. We understand that Mr. Charles Sooysmith is the engineer for the promoters of the last named enterprise.

ACCIDENTS TO FREIGHT TRAINS PARTIALLY AIR BRAKED.*

It has been our custom to place all air brake cars that may come to us on the front end of the train next the engine and couple up the air for use. My attention was directed to the propriety of continuing the practice by the occurrence on my division of an unusual number of accidents to trains thus made up, during last winter and spring. In making a personal examination with a view to find out, if possible, the cause, I am led to believe that it was due to the use of a small number of air brake cars coupled ahead of long trains and used in connection with the hand brake on the balance of the train.

The division is 101 miles long with heavy grades, some as steep as 2%. The maximum number of cars in an east-bound train is 60 loaded to the second summit of St. Mary's, a distance of 34 miles. From this last-named point east for 67 miles, the number of cars hauled in each train varies from 60 to 100 loaded, our average train being about 80 cars.

In pursuing my investigations as to the cause of the unusual number of freight trains that were reported as breaking in two, and which, in many instances, resulted in wrecks to trains and much loss and damage to rolling stock and lading, it was developed that the cause could be attributed principally to the irregularity and want of uniformity in the crews handling the trains, as shown at certain known points on the line where the application of the brakes for controlling trains is a daily practice; this fact was further confirmed in making examination of the crews upon trains which had accidents of this character. From their testimony it was shown that the results were brought about by the sudden application of the air brake, say on from 10 to 20 air-brake cars on the front end of the train next to the engine, before the men working the hand-brake on the middle and rear portions of the train could apply

* Condensed from a paper by Thos. A. Roberts, Supt. Middle Division Philadelphia & Erie R. R., read before the Buffalo Association of Railroad Superintendents.

a sufficient number of brakes to control it in a uniform and regular manner. Again, in relieving the brakes from the cars, the engineman would suddenly release the air brakes from the front end while those in the rear were still applied, such action tending in many instances to pull the train apart. The whole effect of such handling was to produce a heavy shock and strain upon the entire train. If, on the other hand, the entire train could be controlled either by a sufficient number of air brake cars to hold it or by the application of hand brakes in a uniform way, better results, in our opinion, could certainly be obtained, and the evil complained of avoided.

Among other things I found in handling trains by hand and air at the same time that a very bad practice was developing among the train crews, detrimental both to discipline and the company's interests; there was a decided tendency on their part to depend too much upon the engineman for controlling the train, and, consequently, to become careless and indifferent as to the proper discharge of the duties of their position. I found also in every instance where the opinion of the men was asked as to the effect of the use of the air brake and hand brake on the same train they had no hesitation in saying that a train could be better and more uniformly handled by hand brakes alone than by a combination of the two; unless, of course, there were a sufficient number of air brake cars on the train to completely control it by their use. Another feature, and a very important one, enters into the case, and that is that where a train handled in this manner has a large number of cars equipped with automatic couplers, breakage is apt to be heavy where two couplers of different sort come together. It is, however, at this time, so far as I can see, impossible to avoid this feature of the subject, until such time as the old style coupler shall be entirely replaced by the new ones; but it enters into this subject of the parting of trains and the collision of the parts in such a way that the remedy to be applied, in our opinion, is to reduce to the minimum the number of accidents from breaking in two of the train.

To practically test the conclusions I had reached, I gave directions for discontinuing the use of the air brake on freight trains, unless there should be a sufficient number of cars equipped in that way to control the entire train, and to return to the use of hand brakes only. I can say, for your information, that the result has been that we have not had an accident from trains parting since April 17, last, while in March and April, alone, during which time the practice of using the air and hand brakes was in vogue, we had four such cases, attended by much loss and damage. My conclusions, therefore, are, so far as I have been able to practically demonstrate the fact, that the use of the air brake in this way is detrimental to the interests of our companies and should not be continued. In my opinion there is no question as to the efficiency of the air brake on freight trains where there are a sufficient number of cars equipped in that way to control the movement of the entire train, but the combination of part air and part hand brakes is impracticable, as results in our experiment have proved to our satisfaction.

Notwithstanding that I believe my conclusions in this matter are correct, I am aware that many arguments will be presented that may tend to controvert my position. I might mention one of importance that has suggested itself to my mind, and that is that much of the evil of which I have complained by the use of a small number of air brakes on the trains might be corrected to some extent by proper instructions and practical experience in enginemen in the handling of the air brake.

In the discussion which followed the reading of the paper it appeared that railways generally are grouping air brake cars next the engine and that little difficulty is experienced in doing this on level roads. Most roads have rules in force requiring the engineman to apply brakes very carefully on a partially braked train and to delay his release until the brakemen have released most of the hand brakes on the rear of the train.

PERSONALS.

Mr. George C. Waterman, of Chicago, has been appointed County Surveyor of Cook Co., Ill.

Mr. A. Leofred, mining engineer, Quebec, Que., is busy making assays and preparing reports on American and Canadian mines.

Mr. Jacob Johann has been appointed Superintendent of Machinery, of the Chicago & Alton R. R., vice Mr. A. W. Quackenbush, resigned.

Mr. F. M. Canfield has accepted the position of General Agent of the Mozier Safety Signal Co., of Galion, O., with headquarters at Cleveland, O. He was previously train dispatcher at Meadville, Pa.

Mr. Benjamin Norton, Second Vice-President and General Manager of the Long Island R. R., has resigned, and Mr. Everett R. Reynolds, who has been assistant to Mr. Corbin, the president, has been appointed General Manager.

Mr. Francis D. Fisher has been appointed Superintendent, and Mr. A. A. Stuart, Engineer of Maintenance and Construction of the Brooklyn Elevated R. R., Brooklyn, N. Y. Mr. E. M. Hedley has been appointed Master Mechanic, vice Mr. O. Fairhurst, resigned.

Mr. Robert E. Peary, Civil Engineer, U. S. N., has been requested by a number of Philadelphia people to repeat his recent trip to the Arctic regions. Mr. Peary is reported as having expressed his willingness to go, provided he can get the necessary leave of absence from the Secretary of the Navy, which is said to have been granted.

Com. William M. Folger, Chief of the Bureau of Ordnance, U. S. N., is, according to Washington rumors, about to resign his official position on Jan. 1, 1893. It is said that he is interested in the manufacture of armor-plate by the Harvey process, and that he will engage in bringing this new armor to the attention of foreign governments.

Mr. James M. Leighton, Superintendent of the Illinois & Michigan Canal, died at Lockport, Ill., Nov. 12. He was superintendent of the canal before the war, and received his old position back four years ago, succeeding Mr. William M. Thomas. Mr. Creighton gave up his office as superintendent of the canal at the breaking out of the war, and from the close of the war until he resumed office as canal superintendent, he was superintendent for Wells, French & Co., the Chicago contractors.

Mr. D. A. Poynor, M. Am. Soc. C. E., City Engineer of Dallas, Tex., since May, 1890, has resigned his position to undertake the construction of a sewerage system in Tyler, Tex., and to continue his private practice throughout the state. He has been engaged in engineering work in Texas since 1875, having graduated from the University of Nashville the previous year. His address will be Dallas, Tex. Mr. R. W. Havens, City Engineer from 1888 to 1890, has been appointed City Engineer to fill the unexpired term.

NEW PUBLICATIONS.

A READY REFERENCE FOR ENGINEERS AND STEAM USERS.—By Jas. B. Stanwood, M. Am. Soc. C. E., Director Cincinnati Technical School, Houston, Stanwood & Gamble, Steam Engineers, Cincinnati, O.: 12mo, pamph., pp. 48. 25 cts.

This is quite a convenient little book of reference, containing most of the standard steam and power tables in form convenient to carry in the pocket, all brought down to the latest date and with some new matter added. While primarily intended, no doubt, to advertise the firm's slide-valve steam engines, the advertising is confined to modest notices on the front and back cover, and the pamphlet itself is confined to strictly technical matter which as we say, is in very convenient form for reference.

NORTH CAROLINA BOARD OF HEALTH: Report for the Years 1889 and 1890.—R. H. Lewis, M. D., (now) Secretary. 8vo, pamph.; pp. 168; 7 tables; two folding.

Among other matter this report contains a paper in rather a popular style on "The Sanitary Analysis of Water," by Prof. F. P. Venable, and a paper on "The Purification of Water by Means of Metallic Iron," by Mr. Easton Devonshire, Assoc. M. Inst. C. E. The latter paper outlines the Anderson process of water purification which has been described in previous issues of this journal.

REPORT OF THE GOVERNOR OF ARIZONA. 8vo, pamph, pp. 34. N. O. Murphy, Governor.

The report gives some information regarding irrigation and railways within the territory. It is stated that 512 miles of irrigation canals, not including laterals, have been constructed to date. These canals have reclaimed 343,000 acres of land and have made possible the reclamation of nearly 1,400,000 more. The report covers the year ending June 30, 1892.

PROVINCIAL BOARD OF HEALTH OF ONTARIO: Report for 1891.—P. H. Bryce, M. D., Secretary. 8vo, pamph., pp. 131.

Chemical analyses are given in this report of about 40 samples of water taken from the Great Lakes, rivers, deep and shallow wells, throughout the province. Bacteriological analyses of water made before and after passing through the Hyatt filters at the St. Thomas water-works are also given in the report. There are some special reports by Secretary Bryce in the volume on water supply and on sewerage and sewage disposal systems, built and proposed.

TRAUTWINE'S CIVIL ENGINEER'S POCKET-BOOK. Sixteenth edition. Forty-first Thousand. New York: John Wiley & Sons, publishers. $5.00.

This new edition, revised to Oct. 1892, has for its principal new features, the following: A table of reciprocals; tables of heads and pressures, and tables of discharge in cubic feet per second, and in gallons per day; the table of the weight of water in one-foot lengths of pipe of different diameters has been greatly extended, and the coefficients for the conversion of head into pressure and vice versa, have been put into convenient form, with their logarithms. The results of Bazin's experiments with inclined weirs are given, and a new table of Carnegie columns and beams is substituted for the older one. There are a number of smaller additions and changes.

SOCIETY PROCEEDINGS.

MICHIGAN ENGINEERING SOCIETY.—The annual meeting will be held in the Council rooms, at Lansing, Mich., Jan. 17, 18 and 19, 1893. Ever since its organization this society has been advocating and working for better and more economical methods of constructing country roads. The public is becoming, at least to some extent, awakened to the necessity for better roads, and now is a favorable time for action. It is proposed, therefore, to use the second day of the convention for papers and discussions of the road question in its various aspects. Any change in the road laws which will bring about a radical improvement in the country roads, will of necessity open out a wide field of employment for skilled roadmakers, surveyors and engineers. It is hoped there will be a full attendance at the meeting, and every one will be prepared to give his views as to how to make the best roads and the best road laws, and do what he can to assist the law makers in the wisest solution of the road question.

F. Hodgman, Secy.

Climax, Mich.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The annual meeting will be held at the house of the Society, 12 W. 31st St., New York, Nov. 29 to Dec. 2. At the opening session in the evening of Nov. 29, the President, Mr. Charles H. Loring, will deliver his address, and there will be a social reunion. On Nov. 30 there will be the business session of the annual meeting, with reports of council committees and tellers of election in the morning, visit to works, etc., in the afternoon, and a reception and conversazione in the evening. On Dec. 1 there will be papers presented at the morning and evening sessions and visits to works, etc., in the afternoon. On Friday there will be a morning session for the presentation of papers and concluding business.

The following papers will be presented: "Tests on the Triple Engine at the Massachusetts Institute of Technology," C. H. Peabody; "An Interesting Boiler Explosion," F. H. Daniels; "Strains in the Rims of Fly Band Wheels, Produced by Centrifugal Force," James B. Stanwood; "An Analysis of the Shaft Governor," F. M. Rites; "A New Process for Cutting Cams," W. A. Gabriel; "A Simple Difference Engine," George Richmond; "The Strains in Lathe Beds," George W. Bissell; "Tests of Driving Belts," Samuel Webber; "Limit of Propeller Efficiency as Determined by Surface Form of the Propeller," W. F. Durand; "Notes on the Refrigeration Process and Its Proper Place in Thermodynamics," George Richmond; "Hydraulic Reaction Motors" and "Negative Specific Heat," De Volson Wood; "Shall There Be an Overhauling of the Right to Use the Title Engineer," H. F. J. Porter; "Is the Weaving Shed Design the Best Form of Construction for a Machine Shop," John E. Sweet; "To What Extent Can the Milling Machine Replace the Planer," W. S. Rogers; "Experimental Determination of the Heat Generated per Candle-Power in Oil Lamps," D. S. Jacobus; "A New Recording Pressure Gage for Extremely Low Ranges of Pressure," W. H. Bristol; "Tests of a Pump Receiving Suction Water Under Pressure," R. Van A. Morris; "A New Transmission Gearing," H. C. Spaulding; "Comparative Variation in Economy with Change of Load on a Single and Compound Engine," R. C. Carpenter; "Performance of an Overhead Traveling Crane Operated by a Single Electric Motor," Anthony Victorin; "A New Graduating Steam Radiator," John T. Hawkins.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—At the regular meeting Nov. 8, a paper was read by Dr. E. W. Morley, Professor of Chemistry, of Adelbert College, on "Weighing Gases," a brief abstract of which is as follows:

The determination of the atomic weights of oxygen is important in itself; and it has an important bearing on the hypothesis of the unity of matter. One process for determining this atomic weight consists in determining the ratio of the volumes in which oxygen and hydrogen combine, and then determining also the ratio of the densities of the two gases; twice the product of these two ratios is the atomic weight desired. The experimental problem is one of considerable difficulty since the gross weight of the vessel containing the hydrogen weighed is 650 times that of the gas. Since an accuracy of one part in 20,000 in weighing the gas is none too great (though probably impossible), it is obvious that the gross weight ought to be determined (if possible), with an accuracy of one part in 12,000,000. It is necessary to determine the temperature, pressure,

volume, and weight, of a portion of the gas in question. In some experiments, the temperature and pressure of the gas were determined at the instant of closing the stop cock of the globe in which the gas was to be weighed. The observation cannot, therefore, be repeated, and great accuracy is, therefore, difficult to obtain. In experiments now in progress, the temperature and pressure of the gas is not determined; but these are made equal to those of a carefully preserved standard quality of gas whose temperature and pressure were once for all determined with extraordinary care by many observations. This equality can be repeatedly observed; so that greater accuracy is attainable.

The globes in which the gases are weighed had their volumes determined by a modification of the usual process; the displacement of a globe containing 21 litres could be determined by means of a balance capable of carrying only one litre of water. Eight globes have been provided, and their volumes determined. The use of so many globes reduces the effect of accidental errors of the determination of volume. The volumes of the counterpoises of the globes are made equal to those of the globes themselves, within less that one part in 20,000; and the compression on exhaustion which was determined within one part in 1,000,000, was accurately compensated.

The globes with their counterpoises, while in use in an experiment, are inclosed in a desiccator, and not touched; suitable mechanism being provided for effecting necessary manipulations without opening the desiccators. The weighing is effected by the methods of reversals. By means of suitable mechanism, the globe and its counterpoise can be hung from each pan of the balance alternately, the observer remaining at a distance throughout the operation. The accuracy attained is satisfactory; the average error in determining the weight of a globe containing 21 litres, being one part in 16,000,000. The results so far attained indicate that the atomic weight in question is 15.88; it is hoped that the experiments now described, together with experiments by other methods not here mentioned, will suffice to determine the third decimal place with a good degree of approximation. Chas. S. Howe, Secy.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting on Nov. 16, Mr. C. B. Brush in the chair, a paper on "Disputed Points in Road Construction" was read by Mr. James Owen. The engineer's first problem is to convince his clients of the value of his services, it being generally considered that the only use for an engineer is to give the grades. The expenditures are governed by the requirements of the community, with the willingness or unwillingness to furnish the money. Local and climatic influences are very important, and must be given due consideration. Gravel is a very common material, and fine gravel will make a good road for light traffic, but not for heavy roads. The minimum grade should be 0.5% to insure drainage, and the maximum grade in mountainous country, 10%, and grades should be kept as far as possible down to 1%. Underdraining should be carefully attended to, as one dollar spent in this way is better than many dollars spent in repairing badly drained roads. Roads which are "good enough" require good enough repairs, and generally do not get them. Most kinds of hard, square stone will serve for telford foundations. The wearing surface may be of trap, syenite, granite, gneiss or limestone. Trap is best, and granite next. The favor shown limestone is largely due to the superiority of a limestone road to the original mud road, rather than to its comparison with other stone. The thickness of the road should be 10 ins. up to grades of 1%, 8 ins. up to 5%, and 6 ins. on grades over 5%. The general size of stone is 1½ to 1¾ ins., and the success of the New Jersey roads is due largely to the uniformity in size of the material. As a general thing, the broken stone from the quarries is anywhere from ¾ in. to 3 ins. in size., and is dumped on the road. He preferred 4 ins. of 1½-in. stone to 2 ins. of 1½-in., and 2 ins. of larger size.

For telford paving the subgrade should not be rolled, but left so that the foundation stones can be pressed into it to bring the top surface of foundation level. These stones should be well wedged, and clay packing should then be spread to keep the spalls from working up, but too much packing will ruin a road. The packing is then rolled, broken stone laid and rolled, another layer of packing, and then the top course of stones and screenings laid and thoroughly rolled. He preferred more frequent rolling with horse rollers to less rolling with heavy steam rollers, an objection to the latter being their great weight per sq. ft. The rolling is not to complete the road, but to put it in condition to invite traffic upon it to complete the consolidation of the material. Renewals should not be made in patches, but the road, if properly built, should wear out uniformly and be repaired in large sections. A fair average for repairs should be 3 ins. of broken stone every three years.

Mr. E. P. North referred to the bad practice of blindly following foreign precedent, as instanced by the roads in Central Park, New York, where the trap roads are free from shade and have to be kept watered. The constant patching of roads is not necessary with trap rock, but may be necessary with a softer stone, as in North Italy and Switzerland, where roads made with a soft limestone are kept in excellent condition by constant maintenance and repairs, but would be completely ruined if only repaired every year or two. He preferred a 10 or 15-ton steam roller to a 2-ton horse roller. Loam packing is suitable under the latter, but for steam rolling on a trap road, trap screenings should be used, as making a more homogeneous roadbed. As to the question of making thick or thin roads, by the time a 4-in. road requires rebuilding, the heavier road will require resurfacing which will cost about the same. Roads costing $9,000 to $15,000 per mile are not suitable for poor communities.

Mr. Owen said that complaints of taxes were not based on the actual amount, but on the fact that the people were paying more than other people. He had tried rock salt in the water cart, and found one watering per day to be sufficient, but it was too expensive to be carried out. Mr. Collingwood said that road laws, as those of New Jersey, should require the work to be done under a competent engineer, as otherwise the laws will be of little real value. Mr. Brush referred to the great extent to which the road question had been brought to public notice by the bicycling interests.

ENGINEERS' CLUB OF PHILADELPHIA.—Record of business meeting November 5. President James Christie in the chair. Thirty-two members and visitors present. Dr. Henry Leffman read a paper on "The Water Supply of Philadelphia." He said that too much confidence should not be placed upon the results of bacteriological analysis. While the mere determination of the number of living organisms may be made with considerable accuracy, even by inexpert persons, the identification of actual disease-producing microbes, such as the typhoid bacillus, is extremely difficult, and some of the published statements on this subject are untrustworthy. Dr. Leffmann also presented statistics to bear out an assertion which he made several years ago, to show that the cases of typhoid fever in the Kensington district were the result of drinking Delaware water instead of Schuylkill, and said that when the Delaware water was shut off in 1890 the cases of fever and the number of deaths during that and the following year were reduced about one-half.

The Secretary read a paper by Mr. W. W. Thayer, in discussion of this subject. Mr. Thayer enumerated the reservoir capacities of the city of Philadelphia at this time, and called attention to the insufficiency of the pumps to keep them all properly filled. The Director of Public Works, in his report of this year, asks Councils for a new 20,000,000-gallon engine at Spring Garden, a 10,000,000-gallon engine for Belmont, a 10,000,000-gallon engine for Roxborough, and a 15,000,000-gallon engine for Frankford; these would increase the total pumping capacity 55,000,000 gallons. He considered a total capacity of 1,500,000,000 gallons, or one-half of the amount advocated by Dr. Leffmann, all that would be desirable. This amount would necessitate, in addition to the present reservoirs, 13 additional ones, 500 ft. square and 20 ft. deep.

Regarding the filtration system, as each of the 1,000,000 inhabitants of the city may be supposed to use, with waste, 90 gallons per day, then 90,000,000 gallons are required daily to supply Philadelphia. The East Park Reservoir, which is the largest, supplies 335,000 people, and would need a filtering plant of, at least, 30,150,000 gallons' capacity per day. Such filtration he considered little better than nothing, and entirely useless to destroy the germs of zymotic diseases. The suggestion of a double supply would be a good one for new and growing cities, but in a city like Philadelphia the cost of instituting it would be almost equal to that of an entirely new system. The subject of a new source of supply was then taken up, and Mr. Thayer stated that he considered this the ultimate goal for the water question. The rivers available for the supply of the city are the upper Delaware, the Lehigh, the upper Schuylkill, and the north branch of the Susquehanna. The nearest available tapping place in the Delaware is 72 miles distant, and the quality of the water, while very good now, could not be depended upon should the towns on its banks grow into cities of the first class. The upper Schuylkill is strictly mine water, and the nearest point of connection, above Reading, is about 55 miles away. The north branch of the Susquehanna drains a great many towns, and its nearest advantageous tap is above Scranton, about 110 miles distant. The Lehigh River, tapped above Allentown, would, Mr. Thayer considered, furnish the best water at the least expense. This aqueduct would be about 55 miles long, with pumping stations, channels and arched ways, and open as much as possible for aeration. The present Perkiomen Creek could be used for a distance of 21 miles as a natural channel. It would be necessary to build a connection between it and the Lehigh River about 17 miles long, and aother between it and the Philadelphia reservoirs about 24 miles long. This would supply the city with water from two of the purest streams in the eastern part of the state.

Mr. John E. Codman said that, as regards the quantity of water supplied by the Schuylkill, 100,000,000 gallons per day would be ample for the city if drawn directly from the river. If the river were tapped far enough up for a gravity supply, its capacity would not be sufficient. The Perkiomen Creek is not available for more than 95,000,000 gallons, and even adding the supply from other tributaries, it would not be possible to obtain a sufficient quantity from it in time of drought, as the drainage area is not sufficient. New basins may be large, but the water in them will most likely be kept low. The area of the Schuylkill Valley is 18,000 sq. miles, and a population of 400,000 empties its refuse into the river from the towns of Reading, Pottsville, Phoenixville, Norristown, etc. The river is fed by 35 creeks, and four towns use it to carry off their sewage. It is not pleasant to contemplate the fact that we are to drink water polluted in this way. If we adopt the plan of only filtering a part of the supply, a double piping system will be necessary and perhaps a double pumping system. The quantity of water pumped in 1891 was about 55,000,000,000 gallons, of which 11,000,000,000 were by water-power and the balance by steam-power, the latter only being reliable. The objections to the Delaware water, he thought, can not all be sustained, preference for the Schuylkill being probably more a matter of habit than anything else. The waste in the use of water is undoubtedly very great, and would be prevented if the consumer were charged by a meter record. One of the advantages of a double supply system would be that one supply could be kept under pressure, with great benefit in cases of fire. Enough data are now on file in the Water Department to keep a commission of engineers busy for a couple of years without making any new investigations, but no use has yet been made of them. If one of the many plans proposed were adopted, the city might have a satisfactory supply in a short time.

This subject was further discussed by Prof. S. G. Comfort and Mr. John Birkinbine.

L. F. Rondinella, Secy.

COMING TECHNICAL MEETINGS.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Nov 29 to Dec. 2, New York. Sec, F. R. Hutton, 12 W. 31st St.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Dec. 2, Secy., E. K. Smoot, 803 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
Dec. 2, Secy., O. Von Geldern, 719 Market St., San Francisco.

NORTHWEST RAILROAD CLUB.
Dec. 3. Union Station, St. Paul.

MONTANA SOCIETY OF CIVIL ENGINEERS.
Dec. 3, Secy., F. D. Jones, Helena.

ENGINEERS' CLUB OF PHILADELPHIA.
Dec. 3, 1122 Girard St. Secy., L. F. Rondinella.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Dec. 5, Secy., C. L. Annan, City Engineer's Office.

NORTHWESTERN SOCIETY OF ENGINEERS.
Dec. 6, Secy., D. W. McMorris, Burke Block, Seattle, Wash.

CIVIL ENGINEERS' CLUB OF CLEVELAND.
Dec. 6, Secy., Chas. S. Howe, Case School.

DENVER SOCIETY OF ENGINEERS AND ARCHITECTS.
Dec. 6, Secy., Geo. H. Angell, 36 Jacobson Block.

ATLANTA SOCIETY OF CIVIL ENGINEERS.
Dec. 6, Secy., Parker N. Black, Capitol Block.

ENGINEERS' SOCIETY OF PHOENIXVILLE.
Dec. 6, Secy., W. Halliburton.

WESTERN SOCIETY OF ENGINEERS.
Dec. 7, Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Dec. 7, Secy., F. Collingwood, 127 East 23d St., New York.

ENGINEERS' CLUB OF ST. LOUIS.
Dec. 7, Secy., Arthur Thacher, Odd Fellows' Building.

ENGINEERS' CLUB OF MINNEAPOLIS.
Dec. 8, Secy., F. W. Cappelen, 1628 Hennepin Ave.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Dec. 8, Secy., Edward Mead, Norton Building.

ENGINEERING ASSOCIATION OF THE SOUTH.
Dec. 8, Secy., O. H. Landreth, Nashville, Tenn.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Dec. 9, Secy., D. W. Meeker, St. Paul.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Dec. 9, Secy., C. H. McLeod, Montreal, P. Q.

WISCONSIN POLYTECHNIC SOCIETY.
Dec. 13, Secy., M. F. Schinke, City Hall.

ENGINEERS' CLUB OF KANSAS CITY.
Dec. 13, Secy., Waterman Stone, Baird Building.

CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Dec. 14, Wichita, Kan.

NEW ENGLAND RAILROAD CLUB.
Dec. 14, "High Speed for Trains." Secy., F. M. Curtis, O. C. R. R., Boston.

NEW YORK RAILROAD CLUB.
Dec. 15, Secy., H. G. Prout, 73 Broadway, N. Y.

ENGINEERS' CLUB OF CINCINNATI.
Dec. 15, Secy., J. F. Wilson, 24 W. 4th St.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Dec. 15, Secy., C. F. Franson, Portland Block.

TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Dec. 16, 201 Washington Building.

SWEDISH ENGINEERS' CLUB.
Dec. 17, Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago; Secy., John Ericson.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Dec. 20, "Water Purification's." Secy., E. H. Clark, Pittsburg.

WESTERN RAILWAY CLUB.
Dec. 20, Rookery Building, Chicago. Secy., W. H. Marshall.

BOSTON SOCIETY OF CIVIL ENGINEERS.
Dec. 21, Secy., S. E. Tinkham, 36 Broomfield St.

MICHIGAN ENGINEERING SOCIETY.
Jan. 17, 18, 19 Annual meeting at Lansing, Mich. Secy., F. Hodgman, Climax, Mich.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Jan. 19 Secy., P. A. Cherpiot, Macon, Ga.

CENTRAL RAILWAY CLUB.
Jan. 25, Secy., S. W. Spear, E. Buffalo, N. Y., Iron Works.

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GEO. H. FROST.....BUSINESS MANAGER

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

Not satisfied with the laurels gained by his last successful expedition to Greenland, Mr. Peary now desires to repeat the expedition on a larger scale, and with the distinct end in view of going much nearer to the Pole than before, or possibly of reaching it, in addition to definitely determining and mapping the north shore of Greenland. His claim is that the same method of travel which proved so successful in exploring Greenland itself can be extended to travel on the solid ice north of Greenland; and surely he has earned the right to have his opinion on such a matter treated with respect, as one not lightly formed. He has, therefore, applied for and been granted a three years' leave of absence, or the Academy of Natural Sciences of Philadelphia has for him, and we presume he will start on his long and perilous trip early next summer. His leave is stated to have been granted at some inconvenience to the service, as all the civil engineers of the navy are now very actively employed, and more are needed; but we may remark in passing that if needed very badly they can be found.

It is idle to decry such expeditions and ask "What's the use?" The restless spirit of adventure will not cease while there are worlds or parts thereof still to conquer; nor is it true that the certain risk is so much greater than the possible gain as to make it unjustifiable. We must all admire Mr. Peary's pluck, and wish him God-speed; feeling convinced that he will "get there" somehow, if anyone can.

The rapid transit question in London and the proposed underground electric railways for that city are discussed in an article in another column, and we call especial attention to the remarks as to the attitude of the municipal authorities toward the promoters of new projects for increasing the transportation facilities for the enormous city and local traffic. These remarks are especially worthy of consideration at this time, when the city authorities of New York are preparing to sell the franchise for underground railways in this city. The tendency of the London authorities has been to impose more and more severe conditions upon new rapid transit companies, so that now a company finds itself hampered by various restrictions and requirements which are rather beyond its purpose and may involve great expenditures for works not contemplated in the original project. The natural result is that capitalists are getting scared off from such investments, and it becomes difficult to raise the necessary funds. This is very clearly shown by Sir Benjamin Baker, the eminent engineer, in a statement quoted in the article above referred to, and he points out that if the railways are to be built to provide the increased accommodation which is urgently needed, it will be necessary for the municipal authorities to work in harmony with the promoters, rather than to seek to impose unnecessary conditions upon them..

The end of the rather unusual and not very savory controversy between architects over the proposed new cathedral of "St. John the Divine," described and commented on in our issue of April 11, 1891, is the publication of the following announcement (or perhaps it might be more accurate to describe it as a confession) by Messrs. Heins & La Farge, as the result of a compromise of the lawsuit referred to in our former notice, and which had at last reached the stage where it could not well be kept out of court unless compromised:

> The connection between the undersigned and Mr. William Winthrop Kent relating to the Cathedral of St. John the Divine, has been dissolved by mutual consent. We have purchased his interest therein, and all accounts and other matters relating thereto have been adjusted to our mutual satisfaction.
>
> In terminating our business relations with Mr. Kent, we desire to state that he was jointly associated with us in producing the plans of the proposed cathedral, which were submitted to the trustees in open competition, and which procured the invitation for further elaboration thereof. Heins & La Farge.
>
> New York, Oct. 24, 1892.

This long delayed act of justice (for it is now apparent that it was such) was accompanied by a cash payment of some thousands of dollars, we have ascertained, in extinguishment of Mr. Kent's partnership interest in the plans. We will not rehearse the antecedent circumstances further. Those interested will find them in our former article.

But we cannot but feel that there could not be better evidence than this incident of the difference between the modern and medieval spirit which we fear will render fruitless every effort to rival or reproduce those lovely creations of the past, the medieval cathedrals. Whatever his other faults, the medieval architect was intensely and unfeignedly devout. His every act was to the glory of God and not of himself. In the grand words of Emerson, he—

> Wrought with a sad sincerity,
> Himself from God he could not free,
> He builded better than he knew;
> The conscious stone to beauty grew.
>
> Know'st how yon wood-bird builds his nest,
> Of leaves and feathers from his breast?***
> Such and so grew those lofty piles
> While Love and Terror laid the tiles.
>
> The pliant master lent his hand
> To the vast Soul which on him planned,
> And the same power that reared the shrine
> Bestrode the tribes that knelt therein.

The pliant modern master too often frees himself from God without any serious difficulty, lends his hand for a consideration only and lays his stones that they may be seen of men, not that they may be pleasing in His sight. The contrast must surely tell on the final form and spirit of the work. The ancient cathedral has been well described as "a prayer in stone." Such it was, and such the most unsympathetic observer feels it to be, and is correspondingly impressed and awed. The modern cathedral will assuredly not be that in fact, and we have enough belief in the connection between spirit and matter to feel that, therefore, it cannot be made that in effect.

THE BROADWAY FRANCHISE SALE.

The sale of the franchise for the most desirable rapid transit route in the city of New York, which is advertised to take place at 12 m. on Dec. 29, is in many ways a most interesting event and the result will be watched for with unusual curiosity. It is the first departure in this country (on any considerable scale at least) toward a policy which is becoming almost universal abroad, that of deriving much profit for the public both in money and good service, from the sale or gift of public concessions, either in the form of a single advance payment, or of an annual payment of a fixed sum or a percentage of receipts, or of a rental for fixed plant owned by the public, or of a reversion of the entire property to the public after a term of years, accompanied in all cases by stringent conditions to protect the rights of the public from infringement by greedy corporations.

We feel a strong interest in seeing this beginning expand into a general practice. It is absurd that the public should give away for nothing, as it often has done and does, franchises like that of the Third Avenue or Fourth Avenue railway, for example, both of which are so valuable that the entire cost of the fixed plant is more than earned every year and the grant of which was not accompanied by any conditions to ensure good service. The spectacle of such a franchise as that of the Fourth Avenue line, which was practically a free gift of the public to a single wealthy family, being so managed that there shall never be quite enough seats to seat the passengers, either in rush hours or dull hours, or on week days or Sundays, in order to swell still more its exorbitant profits and its owners' overgrown bank accounts, is not an edifying one; it is rather a disgusting one; especially as we look in vain through benighted Europe for a similar spectacle, though there is probably not a line in all Europe so profitable as the Fourth Avenue. In no city of Europe, so far as we now recall, is any public carrier permitted to carry more passengers than the vehicle will seat; and yet they manage to carry all who offer; and yet their cities are larger and as busy as ours; and yet they only get the privilege of carrying passengers seated by paying heavy sums to the city, while our companies are given for nothing the unchecked privilege of working valuable franchises for all they are worth by crowding passengers into cars as hogs are packed in cattle cars; and this not in one city alone, but in all our cities, until the poor dumb public has actually come to believe that it is a part of the eternal order of things, and hardly even opens its mouth to complain, still less raises its hand to strike down the abuse.

At least the beginning of an end to this sort of things was made by the passage of the "Rapid Transit Act of 1891," by which a commission of five men were authorized who were to lay out a route and prepare rules for its construction and operation in the interest of the public only, and were then to give the franchise, not to some favored individual or company, but to whoever would at public sale offer the best terms to the city for the franchise, in the commission's judgment. As we noted at the time (Feb. 7, etc., 1891) the powers granted to this end were sweeping and ample. By section 7 of that act it was provided broadly:

> The board may prescribe all such terms and conditions of sale as it may deem to be for the interest of the public and of the city in which the railway or railways are to be constructed.

And again, later in the act, it is provided, in order to guard against any chance oversight in the original terms:

> The board may, if it considers that the public interest requires it to do so, reject all bids, and readvertise the franchises for sale, with the same or different terms of sale, as often as it may deem necessary in the interest of such city, and shall finally accept that bid which under all the circumstances in its opinion is most advantageous to the public and such city; and no bid shall be accepted without the concurrent vote of four members of the board.

With these ample powers we looked hopefully for provisions in the terms of sale (1) to protect the public in its right to good service so far as possible, and (2) to secure to the city as large a contingent interest in the profits of the line as was possible without making the enterprise less attractive or more dubious to capitalists. We have been disappointed. Such provisions are not there. On the contrary, by some evil chance which it would be unfair to assume was intentional, but which may easily be as unfortunate in its effects as if it were intentional, the terms of sale seem to be so drawn as to leave almost unlimited power in the hands of the commission to oppress, maltreat or annoy the company during construction, if they should choose, and thus to prevent all bona fide competition from bidders who are not certain in advance that they are "solid" with the powers that be. On the other hand the commission needlessly strips itself of all power to protect the public either in its right to good service or to some share in the profits of an enterprise on public property, should it prove to be profitable.

This becomes very clear on examining the terms of sale in detail, and yet it is a discouraging evidence of how little the daily press does to protect the public in its really serious interests, that not a paper in New York seems to have read the terms of sale with care enough to see these facts, which yet stand out upon the surface, and which make it certain (for we hold it to be so; time will prove) that either there will be no bidder for the franchise (which is highly probable) or that it will be knocked

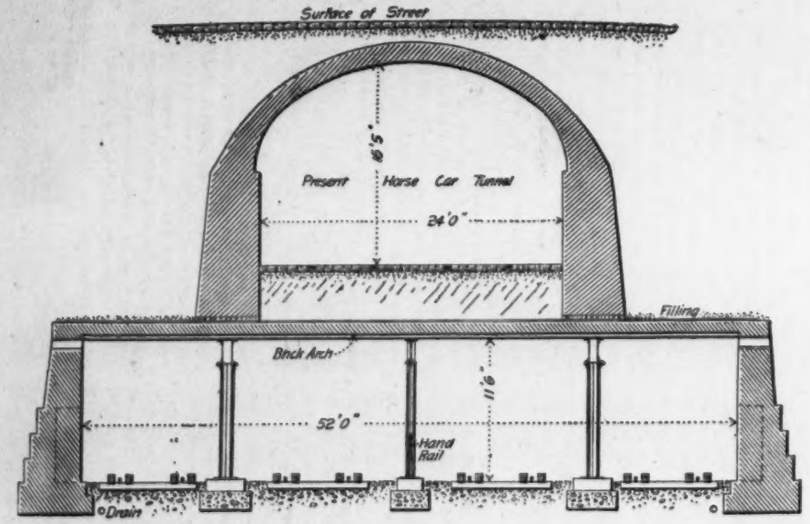

Fig. 1. Section of East Side Branch from 33d St. to 41st St., Under Horse Railway Tunnel.

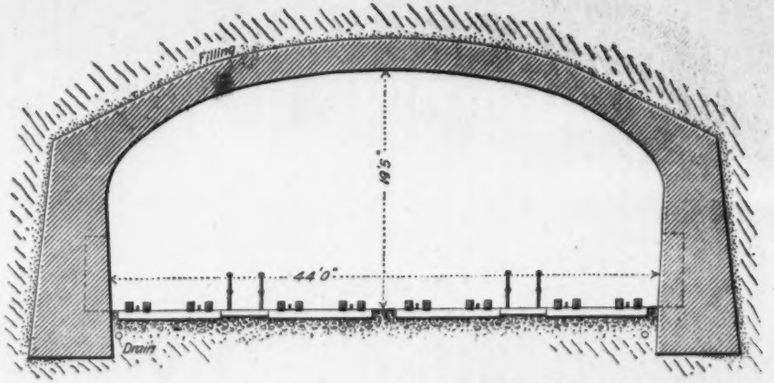

Fig. 3. Standard Section of Four-Track Arched Tunnel.

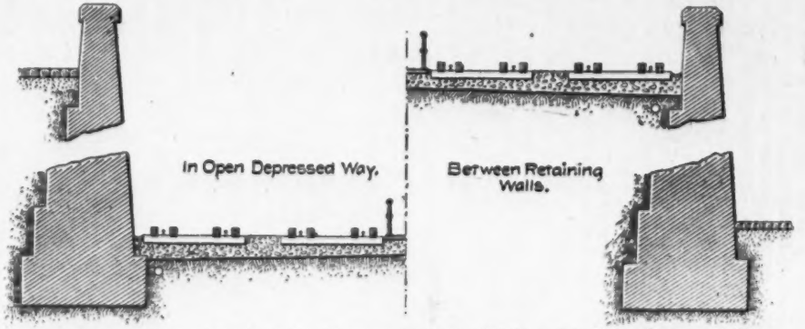

Fig. 2. Standard Four-Track Viaduct Between Retaining Walls and in Open Depressed Way.

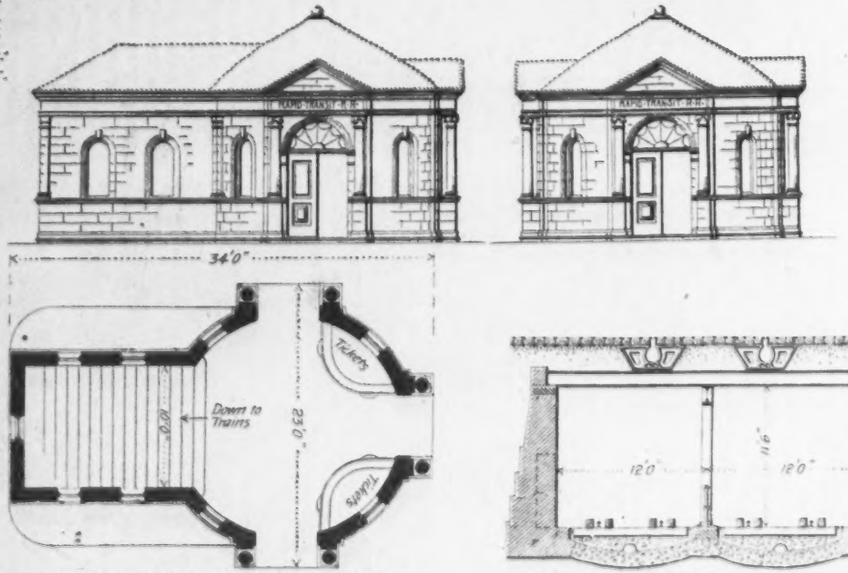

Fig. 5. City Hall Station for North-Bound Trains.

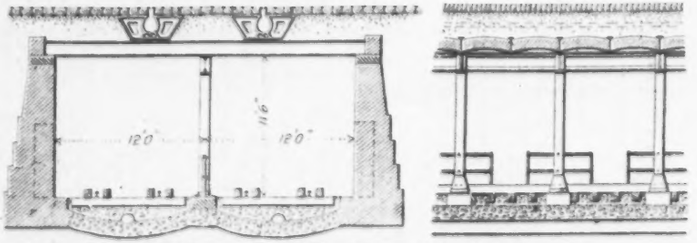

Fig. 6. Sections of Double-Track Loop at Southern Terminus.

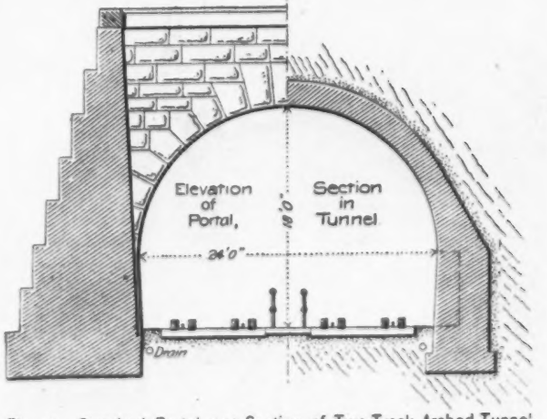

Fig. 4. Standard Portal and Section of Two-Track Arched Tunnel.

STANDARD PLANS FOR NEW YORK CITY RAPID TRANSIT RAILROAD.

John Bogart, Chief Engineer. W. B. Parsons, Deputy Chief Engineer.

down for some paltry sum without real competition, leaving the buyer of the franchise complete master of the situation, so far as the public interests are concerned, on the sole condition that he keep himself "solid" with the commission during the period of construction. In fact, as the law under which the commission acts makes no provisions for paying it anything except a lump sum for its service in "locating" the lines, to be fixed by the courts and paid by the bidder before construction begins, it looks as if the commission might pass into innocuous desuetude, if not out of existence, before construction is fairly started.

In the first place, of the many possible ways of securing compensation to the city, the commission has selected the worst, cash down in advance. This is the one thing of all others that those undertaking a speculative enterprise requiring an enormous investment at best, object to most, as most burdening the enterprise. They much prefer, and can much better afford, to give a large contingent interest. Thus the private individual with an enterprise to float who wants to sell for cash what has cost him nothing, and then to get out, stamps himself as a fraud at once. In addition to the obligation to raise $60,000,000 to $70,000,000 for construction, several millions of which must be on hand in cash before the work is started, the bidder is obliged by the terms of sale to pay in at once or put at risk:

1. 10% of the amount bid (at sale), say 10 cts., to	$100,000
2. Guarantee deposit (at sale)	1,000,000
3. 90% of the amount bid (in 30 days), say 90 cts., to	900,000
4. Back expenses of commission (in 30 days), say	80,247
5. Current expenses of commission (in 30 days), say	30,000
6. Compensation expenses of commission (in 30 days), say	50,000
7. Security bond (in 4 mos.)	2,000,000
8. State tax on stock (½%)	62,500
9. Initiatory expenses of bidder, say	100,000
Total	$4,331,747

By the time that construction is fairly under way the amount at risk will be nearly double this; all of which the bidder stands to lose if things should go seriously wrong in any way, a chance which every bidder figures on as possible.

2. But in addition to this the franchise is to be sold for the unconscionable term of 999 years, without even a reversion of the works to the city at the end of that period. Now it is a fact readily demonstrated both by reason and experience that the attractiveness of the enterprise to private investors would not be seriously diminished even had it been stipulated that the works should revert to the city at the end of 50 or 100 years. The present worth of $1 payable at the end of such a term is an inconsiderable sum. The present worth of $100,000,000 at the end of even half or a quarter of a thousand years is so small a sum that a beggar on the streets would not stop to pick it up, for he could not see it. But the city lives forever. The reversion of $100,000,000 even at the end of a thousand years is worth something to it, and at the end of 99 years would have been a very valuable asset. Neither is worth anything to the private investor, either to sell or give away. He will not pay a penny more cash down for it. This is proved by experience with an immense number of public works in Europe (as for example, all the railways of France, which revert to the nation a few decades hence), but may be shown numerically as follows:

The present worth of $100,000,000 payable at the end of various periods up to 300 years, at various low rates of interest, is as follows:

At end of.	At 3%.	At 4%.	At 5%.	At 6%.
50 y'rs.	$23,342,100	$14,071,100	$8,720,370	$5,428,815
100 " ..	5,203,200	1,980,020	760,450	294,720
200 " ..	270,745	39,205	5,782	86
300 " ..	14,088	776	44	4

Only a city or state figures on such low rates of interest as this, however. The private investor is not going to touch a politically controlled franchise unless he thinks he sees 8% to 10% in it for him at least. At these rates, the present worth to bidders of the surrender of their $100,000,000 investment at the end of various periods up to 200 years (will not go further) would be as follows:

Present worth $100,000,000.	At 8%	At 10%.
At end of 50 years	$4,689,420	$851,854
" " " 100 "	45,459	7,257
" " " 200 "	($20.67) 21	(52.6 cents!)

How wicked and silly seems the sacrifice of the city's interests by the terms of sale in the light of this showing! By presenting to the possible bidder what he will only value (if he be a well posted business man) at 53 cts. in cash, the commission propose to deprive the city of the ownership of $100,000,000 worth of highly lucrative property for 999 years; nay, forever! For the property is not, even at the end of 999 years, to revert to the city. But the sacrifice is even greater than this. No business man will pay $1 cash for an interest which is only worth $1 now and does not mature for 50 years. Therefore, every bona fide bidder at the sale, if there should chance to be one, would greatly prefer to surrender the whole property to the city at the end of 50 years than to pay even $851,854 cash down for the franchise; and surely the commission do not expect to sell it for less than that.

Let us for curiosity sound the full depths of the 999-year folly. The present value of $100,000,000 at the end of 999 years (not $1 but $100,000,000, be it noted) is as follows at various low rates of interest:

At 3%, $0.00,001.5
At 4%, 0.00,000,000,096
At 5%, 0.00,000,000,000,006.8
At 6%, 0.00,000,000,000,000,000,190.8

The comma enables one to read readily what the present value of this sum is in cents. In other words, we can at 6% put 1 cent to-day at compound interest until it amounts to $100,000,000; throw it all away except 1 cent; keep that at compound interest until it is $100,000,000; throw all that away again but 1 cent; put that again at compound interest, and at the end of our 999 years we shall be more than half way toward a third $100,000,000, which we may well believe will be useful to the city even 999 years from now, for the city is likely to still exist, and perhaps be much poorer than now!

The folly of granting a perpetual franchise to a private corporation, although often perpetrated, was foreseen and guarded against by the framers of the law from which the commission derives its powers. The law provides (section 7)

> All sales of such rights, privileges and franchises shall be made for a definite term of years.

The sale of the franchise for 999 years conforms to the letter of the law, but it is practically a perpetual franchise, and as such a violation of the spirit of the law, and one for which it is very difficult to find an excuse.

Conformity to the spirit as well as the letter of the law, which clothed them with large powers, and restricted them only in a few essentials, is what the public expects and requires. The violation of the spirit is so plain that there is at least a chance that the courts would hold the long term to be a violation of the letter of the law also, as in effect a perpetual franchise.

Doubtless the people who want rapid transit at any price will say that the life and returns from the franchise do not matter if it contains provisions protecting the public with respect to the service rendered; but the terms of sale contain two opposite errors of the gravest magnitude in this respect: (1) they contain the most minute provisions for control of construction; (2) they contain absolutely no provisions for control of equipment or operation which the constructing company cannot drive a horse and cart through once the contract is signed. The apparent exceptions are not real ones. The terms of sale strip the commission of real power over anything except the details of construction, where they could if they choose annoy and harass the company greatly; and every bidder who does not bid from the inside will naturally take that chance into consideration.

Now the details of construction are the one thing which can be most safely left to the company's own discretion without supervision, because all its interests require sound and permanent work. A few general requirements as to the quality and appearance of the work, disposal of stations, lifts at deep stations and the like, were proper enough; but no company wants to build work which will fall down or endanger buildings which they must pay for under the common law, or move sewers and pipes badly, so as to leak and have to be done over, or lay down light rails or poor guard rails. They can also get as good engineers as the commission to look after these things, and are far less likely to select them on other grounds than merit. Yet the terms of sale provide nominally that:

> If the constructing company shall use any method of construction which the commission shall deem as (sic) unsafe, or as not giving the best possible result, it may in its judgment order such method stopped or altered, and the constructing company must obey such orders immediately.

But the usual unfair provision follows:

> Although the said commission will supervise the work of construction, nevertheless, such supervision shall not relieve the constructing company from any liability whatsoever

On the other hand, we look in vain through the terms of sale for any express or implied conditions, or any reserved power to make them, which give the commission or anyone else power to:

1. Regulate the speed of trains. Nothing even looks toward a reservation of this power in the public interest.
2. Regulate the seating capacity. There is only the absurd and meaningless provision: "Each car must have ample and comfortable seating capacity for the number of passengers TO BE carried by the car." If this provision means anything it means that each car must have "ample" seats for all the passengers it is intended to seat. If the commission mean that each passenger is to have a seat or no pay, why do they not say so? They do not mean it nor mean anything whatsoever which is intelligible or enforceable.
3. There are no powers reserved or conditions fixed to regulate the number, headway or proportions of express or way trains. It is only said that the company shall furnish "sufficient" accommodations in trains run "at regular times to be fixed by public notice," under penalty of an action for damages by the party aggrieved" for "neglect or refusal" to carry him in its regular trains! The very specification of this remedy excludes resort to any other.
4. There are no provisions for proper heating and lighting except that the "plans and methods" for so doing must be submitted and approved "before adoption." Once approved the commission (if it then exists) has in terms abandoned any right to change its mind or exercise a continuing supervision.
5. There are no provisions to ensure proper or effective motive power able to maintain, say, the present speed of the elevated trains. The provisions on this head are particularly curious, because they read as if, here at least, something real and important and specific was required. They read:

> The motor must be sufficiently powerful to start readily a train of 8 cars, each weighing in addition to its load not less than 30,000 lbs., on a gradient of 1½%; and the motor must also be able to maintain the same train at a speed of not less than 40 miles per hour on a level gradient.

This is mere sound and words, signifying nothing. The first part means only that the engine must have 10 or 12 tons on its drivers; the second part means still less. Any old tea-kettle of an engine "fit for scrap" can do as much as this. What is wanted is an engine which can "pick up a train and walk off with it" on a 1½% grade, without delay to get up speed, so as to average 30 or 40 miles per hour between express stations; a vastly different thing and one which requires greatly more power than that specified.

What may prove to be a still more serious defect in the terms of sale and accompanying plans is that the express requirements of the law have not been complied with, so that the constructing company once organized may with impunity (1) defy the authority of the commission if it seeks to exercise any such general and continuing control over construction and equipment as the terms of sale contemplate, or (2) quash the entire contract whenever it suits their convenience. The law is specific (section 4) that the commission shall (1) prepare "general plans of construction" (and operation) which they did a year ago (see our columns for October 1891) in due and proper form. But is even more specific in stating (section 6) that before a sale of the franchise is attempted, the board shall

> Proceed to prepare detailed plans and specifications for the construction, including ALL devices and appurtenances deemed by it necessary to secure the greatest efficiency, public convenience and safety, including plans and specifications for suitable support, turnouts,

switches, sidings, connection, landing places, buildings, platforms, stairways, elevators, telegraph and signal devices, and other suitable appliances incidental and requisite to what the board may approve as the best and most efficient system of rapid transit in view of the public needs and requirements.

Now in the whole mass of drawings accompanying the terms of sale there is hardly one which would be held by any engineer or court to be what is technically known as a "detail plan;" i. e., one from which the quantities can be taken out with tolerable accuracy, for making a preliminary estimate or bid. Nor in any of the conditions of the terms of sale (unless it may be the motive power specification above noted, and a few unimportant details like it) is there anything which by any stretch of charity can be called a detail specification. It is attempted instead, to comply with the plain (and obviously reasonable) requirement of the law that the board shall determine and state before the sale just what it demands, by specifying in the matter of block signals, for example, that "the best and most efficient system of block, switch and train signals shall be adopted and constructed, the plans for such system TO BE as approved by said commission." In this manner the commission attempts to reserve a general power to do AFTER the sale what the law in terms commands them to do BEFORE the sale, so that bidders may know what to count on. The same dodging of immediate responsibility, and attempt to reserve an indefinite future power to "meddle and muddle" as much as they please runs through the whole terms of sale. If so, it seems possible that the courts might be compelled to declare the whole instrument void, as being beyond and at variance with both the spirit and letter of the law, which although it provides that the board shall have power (but only by a vote of 4 to 1) "to alter or ADD TO the detailed plans and specifications," yet the significant and plainly proper proviso is added (section 14):

PROVIDED ALSO such modifications be first approved by a vote of two-thirds of the directors of said corporation at a special meeting called for the purpose.

So we might go on to cite a number of other particulars in which the public interests have not been duly guarded, such as the truly monstrous provision (par. 31) which nothing in the law requires, that the company may increase its capital stock to any extent, with reason or without reason, for value received or as a mere gratuity; provided only that four members of the Rapid Transit Commission consent in their unchecked discretion.

The one saving clause in the terms of sale, however, is that the commission reserves power to reject all bids and re-advertise the franchise under "the same or different terms of sale as often as it may deem necessary in the interest of the city of New York;" and to accept only "that bid which under all the circumstances is in its opinion most advantageous to the public and the city," and it further reserves the right to deliberate over the bids after the sale.

Therefore there is nothing in the terms of sale to prevent any one's bidding, or the commission from accepting a bid of $1 cash, and a contingent percentage of gross or net receipts to the city, or a reversion of the works to the city at the end of a (comparatively) short period of years. The franchise will certainly be one of great and increasing value, the only dubious period being that of construction and the early years of operation. In the anxiety to secure the franchise at the smallest present risk there may be one or more bidders who will volunteer such bids. But there is nothing in the terms of sale to encourage them, or to intimate that anything but cash down will be considered. They will be merely bidding in the air, so to speak, and, therefore, the best offer made of this (or any) kind is not likely to be as favorable as it should be or might be.

But with the cue thus given, the commission has power to revise all the terms of sale, to cover all the points herein mentioned, and others not mentioned which might have been, and thus in the end to secure a favorable contract for the city. We will hope that they will do so. Few men are ready to admit that they have made mistakes until they are obliged to, and, therefore, it is hardly to be expected that the commission will make any formal change in the terms of sale until after the first sale has failed; but they could at least cause it to be known that they were prepared to consider favorably bids which gave the city a reversionary ownership after a term of years or a contingent percentage in gross or net receipts, or both, and thus do no harm and possibly much good.

The first use of riveted sheet iron pipe in hydraulic mining was made, according to the "Mining and Scientific Press," in 1855, at the town of Red Dog, Nevada Co., Cal. Previous to this time many miners had been hydraulicking their claims in a small way with hose made of heavy canvas. The width of canvas being 22 ins., the hose was about 7 ins. in diameter and would burst under very small provocation. Two miners named McAuliff and Curry, the latter afterward famous as one of the owners of the Gould & Curry mine, wished to secure a heavier pressure for working their claim than the hose would stand, and they engaged a tinsmith at Red Dog to make them a pipe of No. 22 sheet iron, such as is used for stovepipe. Through this they drew the hose, relying on the canvas for watertightness and the iron for strength. In a few months, however, the rust of the iron rotted the canvas and it fell to pieces. The sediment, however, had stopped the leaks in the iron pipe and the miners went on using it without any lining with entire success.

The rainfall for October in Providence, R. I., according to the records of the City Engineer's Office, was only 1.36 ins. This is 2.29 ins., or 63%, below the normal rainfall (3.65 ins.) of the last 61 years. Since 1831 the rainfall has been less than 1.36 in. seven times only, the lowest being 0.92 in. in 1874, and 1.00 in. in 1879. The total rainfall from Jan. 1 to Oct. 31, 1892, was 29.77 ins. This is the lowest rainfall for the last 28 years, and the lowest since 1831, with only ten exceptions. The lowest recorded in the same office since 1831 is in 1846, 22.84 ins.

Prof. Nansen proposes to leave Norway next June, with five years' provisions, on his specially constructed ship, for his adventurous drift to the North Pole. At least he expects to find a powerful natural current setting north from the neighborhood of Nova Zembla, and to get into this, with a ship peculiarly constructed to resist "nipping" by ice-floes, and to be frozen-in and then drift to and across the North Pole and eventually thus reach Greenland. He bases his theories on the alleged drift of certain relics of the ill-fated Jeannette expedition, of 1879-81, from the mouth of the Lena River to Julianshabe in Greenland, found in the latter place in 1884 frozen in a piece of ice. Prof. Nansen has the courage of his convictions, and at the expense of the Norwegian Government and King Oscar, he proposes to start out, and says that it may take him from two to five years to get around to the world again—if he ever does.

Ten miles of the Congo railway are completed; from the starting point at Matadi, 10 miles from the mouth of the Congo, to Palaballa. Two years have been consumed in constructing this first section, but the chief obstacles are said to have been passed. Nearly all of this 10 miles of roadbed has been blasted out of the solid quartzite hill skirting the Congo, and the Leopold ravine, by which the road leaves the river, presented even greater engineering difficulties. One 200-ft. bridge spans the Mposo River and the longest bridge, of the seven of importance required, will be the 330-ft. span over the Ngongo River. The total distance from Matadi to Stanley's Pool, or around the cataracts of the Congo, is 235 miles. But the country above Palaballa is said to be comparatively easy for railway building, and it is expected that the work will be rapidly pushed. Capt. Thys is in general charge, and about 2,500 natives are employed on the work.

The Liverpool elevated railway will probably be opened to traffic before the end of the year. The trains are to make the 5¾-mile trip in 25 minutes, including stops, and run at 5-minute intervals for most of the day. Two cars will make a train, and each car is 45 ft. long, weighs 14 tons, and will accommodate 56 first and second class passengers. The cars have a central passage way, with seats for two on each side of the passage, and have side doors. They were described in our issue of Sept. 1.

Vitrified paving brick is not likely to be adopted by the St. Louis Board of Public Improvements, for streets subjected to heavy traffic. The Board says that as compared with granite the price of brick pavement is undoubtedly very low. But on streets with medium-weight traffic, vitrified brick only lasts five years and the supply of really reliable vitrified paving brick is limited. City Engineer C. P. Chase, of Clinton, Ia., in discussing vitrified brick pavement, says that all vitrified brick should be annealed, and thus toughened and made elastic. He claims that much of the objection to their use comes from the omission or careless performance of this treatment. Mr. Chase, who is a warm advocate of brick for pavements, thus sums up the comparative merits of various paving materials:

	Granite.	Brick.	Asphalt.	Sandstone.	Wood.
Durability under traffic.....	1	2	3	4	5
For cost.....	5	1	4	3	2
For action of elements.....	2	1	4	3	5
For noise and dust.	4	2	1	5	3
Repairs.....	2	1	4	3	5
Service on grades..	1	2	5	3	4
For health.....	2	3	1	4	5

LETTERS TO THE EDITOR.

THE LATEST CHINESE RAILWAY.

Sir: Besides the railway lines mentioned in my paper on "Telegraph Lines and Railways in China," published in your issue of Nov. 17, a railway 17 miles in length has recently been opened for traffic between the great iron mountain Tieh-Shan, where the iron ore for the furnaces at Wuchang is to be obtained, and a port on the Yangtze. The road is designed for transporting the ore.

Very truly yours,
Romyn Hitchcock.

Washington, D. C., Nov. 19, 1892.

THE ETHICS OF CONSULTING PRACTICE.

Sir: Accept personally my sincere thanks for your admirable editorial, in your issue of 10th inst., on "The Ethics of Consulting Practice;" written at an opportune time; fitting in its application; moderate in its tone, and dignified in its whole discussion. You have caught exactly the present unsatisfactory state of the profession. This has been my text for the past 10 years. I wish you had written the article a few weeks earlier; I would certainly have added it as an appendix to my paper, read before Canadian Society of Civil Engineers, and just published, on "The Professional Status." I take pleasure in sending you a copy of the same. We shall hear more on the subject at our annual meeting next January.

Respectfully,
Alan Macdougall.

Toronto, Nov. 14, 1892.

(We think it eminently proper that both the American Society of Civil Engineers and the Canadian Society of Civil Engineers should take action to establish, formally at least, the two rules of conduct which we discussed in the article referred to as binding upon every member in good standing. It would be for the common good of all to do so, and could work injury to no one fit to be a member of such a society, for we hold the spirit of those rules to be already established practice.—Ed.)

THE FIRE IN THE CHICAGO ATHLETIC CLUB BUILDING.

Sir: As the fire in the Chicago Athletic Club Building, alluded to in your last issue, has been the only real test so far of a "fireproof" building, some details of the result may interest your readers. I examined the structure the next day, and can therefore vouch for the facts.

The fire occurred in a large hall, two stories high, and which occupied an entire floor. The walls and ceiling were originally covered with hardwood paneling, (which was completely burned off), and the floor had been used for storing the lumber needed in other parts of the structure, the piles being in many cases 6 and 8 ft. high. Some idea of the amount burned may be gathered from the fact that after the fire the floor was covered with a layer of charcoal 9 to 12 ins. deep.

Considerable damage was done to the tile covering of the iron (no brick was used except for the outside walls), but none of the columns or girders or floor-joists were even bent, and with the exception of some roof tees and ornamental iron, the metal which had been exposed to the fiercest heat was uninjured. Half of the fireproofing of the columns had fallen off, owing to the fact that wooden nailing strips had been placed between the tiles, and when burned through had left the latter unsupported. The fireproofing on the walls and the tile partitions were also injured and broken, and in some cases the under side of the floor arches had fallen out. The injury to the fireproofing seems to have been due to water, for, as no iron could have stood such heat while unprotected, the covering must have held together until the water split it off, by which time the diminution of the fire would prevent any damage to the metal. Above the hall little harm was done except to the woodwork, as the fireproof floor kept the heat from passing through to any extent.

I understand that Mr. Corydon T. Purdy, the well known structural engineer of this city, has expressed an opinion that the result has justified the expectations formed of this type of structure, and indeed it is hardly necessary to say that had ordinary methods of construction been employed, the building would have been completely wrecked.

Yours truly, W.

Chicago, Nov. 14, 1892.

(We shall publish further particulars of this practical fire test later.—Ed.)

THE DISTRIBUTION AND MEASUREMENT OF ILLUMINATION.

Of all the forms of energy which are distributed as articles of commerce, it is probable that light is the form which is sold with least attempt at direct measurement. Energy in the form of mechanical power is measured with fair accuracy by dynamometers, friction brakes and indicators; electrical energy in all its forms is measured with great accuracy; stored energy in the form of fuel or of chemicals or gases under compression is easily meas-

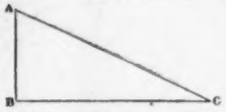

Fig. 1.

ured by weight or volume, and heat in both its intensity and absolute quantity is subject to accurate determination.

The measurement of light, however, even among those engaged in its commercial supply, is on so unsatisfactory a basis that nearly all the light commercially supplied is measured not by its amount but by the amount of energy or fuel used to produce it. For example, the user of electric light pays for a certain amount of electric energy delivered to his house, which his lamps may utilize with greater or less efficiency. The user of gas light pays for so many cubic feet of gas which may be largely wasted by poor burners or over pressure. Even when light is measured in terms of candle-power, as when a city contracts for arc lights of a given candle-power, the measurement is of the intensity of so many sources of light, and the supply from them may be largely wasted by bad arrangement. The candle-power is a fairly satisfactory unit for the intensity of a source of illumination, but we have no generally known unit or method of measurement of the intensity of illumination in a room, a railway car, a street, or other place where artificial light is supplied.

In preparing the series of articles on "The Comparative Merits of Various Systems of Car Lighting," recently published in this journal, the need of a unit for the measurement of illumination was felt and the unit adopted was defined as the illumination produced from a source of light of 1 c. p. intensity on a plane 4.5 ft. distant. This unit was chosen as being about the average distance of the lamps in a car from the points where light for reading is desired.

In a paper recently read before the Institution of Civil Engineers, by Mr. A. P. Trotter, measurement of illumination was fully discussed and illumination photometers were shown and described. The unit of illumination used by Mr. Trotter (and which has already been used by others to a limited extent) is a candle-foot, i. e., the illumination produced by a light of 1 c. p. upon a plane 1 ft. distant. To give some idea of the value of this unit, it is about the illumination produced by a common incandescent lamp (16 c. p.) or a fairly good gas jet upon a plane held 4 ft. distant.

The total illumination of the full moon when near the zenith is in London atmosphere 1-60th to 1-100th of a candle foot. The diffused light from the surrounding sky brings the total illumination up to 1-30th candle-foot, according to Mr. Trotter. The illumination of ordinary sunlight has not been determined, but the light from a great white cloud on a bright day has been determined by Mr. W. H. Preece to be about 28 candle-power.

With an accepted unit of illumination and satisfactory means for measurement, it becomes possible for those in charge of lighting to specify the degree of illumination which they desire and determine whether it is furnished. To enable engineers to do this was stated by Mr. Trotter to be the object of his paper. Taking up first the matter of units, the value of the candle-foot depends on the two factors of candle-power and distance. The candle-power is the light produced by a standard candle consuming 120 grains of sperm per hour. The French have introduced two other units for illumination, the "carcel-meter" and the "bougie-meter." The former has been proposed for English use under the name "lux;" its value is 1.12 candle-foot. The "bougie-meter" equals 0.0891 candle-foot. We abstract Mr. Trotter's paper as follows:

The candle-foot is a very comfortable illumination. It is for most people the best illumination for reading and is to be found on most well lighted dining tables. More than two candle-feet is seldom attained in artificial illumination. One candle at 1 ft. is equivalent to four candles at 2 ft., or to nine candles at 3 ft.; but to say off hand how many candle-feet are produced by a 16 c. p. lamp at a distance of 8 ft. is rather puzzling at first. The illumination is $16 \div 8^2 = 0.25$ candle-foot.

The candle-foot, as already defined, assumes that the illuminated surface directly faces the source of light. If the surface is inclined to the direction of the rays of light, the illumination will diminish in proportion as the projected area of any part of the surface diminishes, when viewed from the source of light. The visible surface varies from unity, as seen full; to nothing, when seen on edge. The decrease varies, in fact, with the cosine of the angle of incidence. So little has the question of illumination been studied, that there is some ambiguity as to what is meant by the angle of incidence. It is a well-established convention among writers on optics, that the inclination between a ray and the perpendicular to a surface shall be called the angle of incidence. A ray, proceeding horizontally, will therefore be of 90° incidence; and a ray falling on the point immediately below the lamp, will be of 0° incidence on the horizontal plane beneath it.

Distribution of Illumination.—The nature of the illumination of a horizontal plane by a light radiating uniformly in all directions is the most simple, and, at the same time, the most useful and common problem for outdoor work. Assuming the candle power of the light and its height as constant, the illumination at any point on the plane varies inversely as the square of the distance from the light and also as the cosine of the angle of incidence. Now, in Fig. 1, let the source of light be at A, and the illumination at the point C be required, then the illumination will be

$$i = I \cos. B A C. \left(\frac{1}{A C^2}\right)$$

But $AC = \frac{A B}{\cos. B A C}$ and A B, being constant by hypothesis, may be considered equal to unity. Substituting these values in the above equation we have

$$i = \cos.^3 B A C.$$

That is, with constant candle power and height of lamp, the illumination will be as the cube of the cosine of the angle of incidence. The full line in the diagram, Fig. 2, shows the illumination produced at various points upon a horizontal plane by a luminous point that gives illumination equal to unity at a point directly beneath it. Illumination on a horizontal plane decreases so rapidly with the distance, that at an angle of incidence of about 37° it falls off to one-half, at about 40° to one-third, and at 62° to one-tenth of the maximum.

Examples of Distribution.—By the practical application of the cosine law, the illumination which will be produced by any given arrangement of lights may be determined. Figs. 3, 4, 5 and 6 show the distribution of illumination upon a plane from lights spaced 1, 2, 3, and 6 times their height apart. The dotted lines show the curves of illumination from each light and the several full lines show the total illumination at

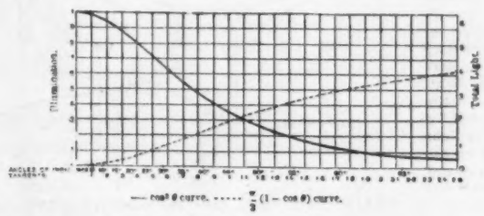

Fig. 2.

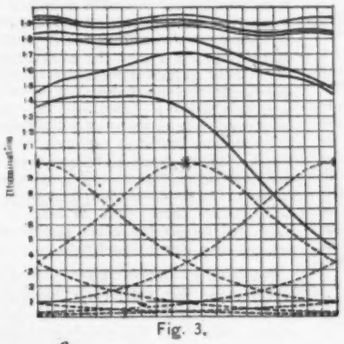

Fig. 3.

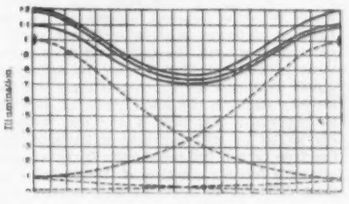

Fig. 4.

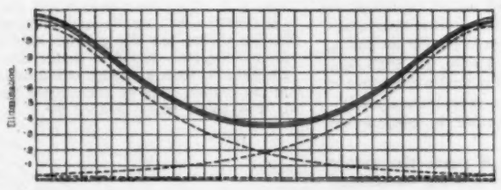

Fig. 5.

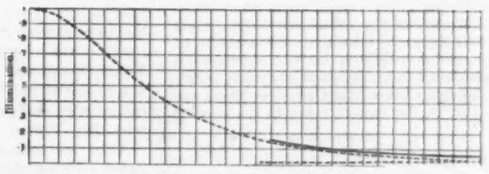

Fig. 6.

DIAGRAMS SHOWING DISTRIBUTION OF ILLUMINATION UPON A PLANE FROM LIGHTS VARIOUSLY SPACED.

each point from 2 lamps, 3 lamps, 4 lamps, etc. It will be seen that with an indefinite series of lamps spaced as shown in Fig. 3 the variation is very small, by calculation only 2¼%. In Fig. 4 the minimum is 35.8% less than the maximum, and in Fig. 6, which is a common arrangement in street lighting, the variation is about 93.7%.*

Two practical modifications must be considered with regard to these results, one being the reflection by neighboring houses, which assists the illumination of the region midway between the lamps, and the other being the shadow which is always to be found below a lamp, whether thrown by the gas-burners and the bottom framing of the lantern, or by the lower carbon of an arc-lamp. The first of these modifications, though specially looked for by the author in street-lighting measurements, was hardly appreciable except in cases of very feeble illumination. The second is a very marked feature with all street lamps except those which are provided with good reflectors.

The light of ordinary gas burners is not quite uniform in all horizontal directions, since the flame is not perfectly transparent, and there is some variation of candle power at different angles with the horizon,** but these are trifling compared with the natural variations which have been described. The light of arc lamps is emitted in a very well defined manner, and does not differ materially in different makes of lamps, provided that the ordinary pair of carbons are used with a continuous current. With angles of incidence from 0° to about 55°, the light is obstructed by the lower carbon, which determines the candle-power. Beyond 55° the light follows a regular law, but not that of the cosine-cubed, for the light is not emitted from a mass of flame but from a horizontal disk or crater. The projected area of this crater, as seen from any direc-

* See similar diagrams in Eng. News, Dec. 19, 1891.
** See Eng. News, Dec. 19, 1891.

tion, varies as the cosine of the angle. The cosine being introduced for the fourth time, the illumination varies as the fourth power of the cosine.

Street Lighting.—Electric incandescent lamps have rarely been used with success for street lighting up to the present; but too much has been expected from them. Street lighting differs from almost all other lighting in that the illumination produced on the ground is not by any means the only important result; but

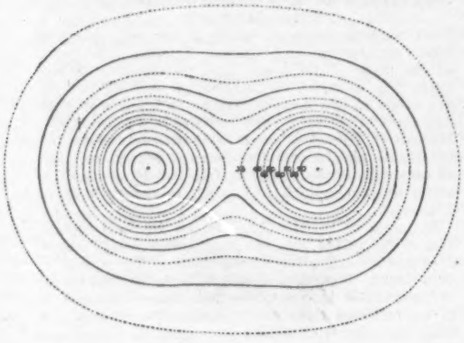

Fig. 7.

since this illumination is so marked a feature of a well lit street, it is often assumed to be the sole object of street lighting. A very important function of street lamps is that of beacons to mark out the road. For the lighting of docks, wharves, railway goods yards and other open spaces, the horizontal illumination demands most attention. But it may be suggested that for street work and the lighting of large interiors, such as railway stations, the illumination of side-walls is quite as important, and that if any one wishes to consult his watch he will not hold it horizontally, but with the face turned full toward the light. It appears best to aim at a fair illumination of the ground, this being the most difficult. If there are houses near the lamps, so much the better for the general effect, but the lamps should not be spaced further apart for this reason.

Distribution Over a Plane.—The arrangement of lamps for outdoor lighting almost always consists of rows of lamps set alternately on each side of a street or a single row down the middle. Figs. 7 and 8 show the contour lines of equal illumination on a plane from lamps spaced 3 times and 1½ times their height apart respectively. Full lines are drawn for the contours of 90, 80, 70, etc., and dotted lines for the intermediate contours, the maximum illumination at the point immediately below the lamp being taken as 100. These are the theoretical curves, the variation due to the varying

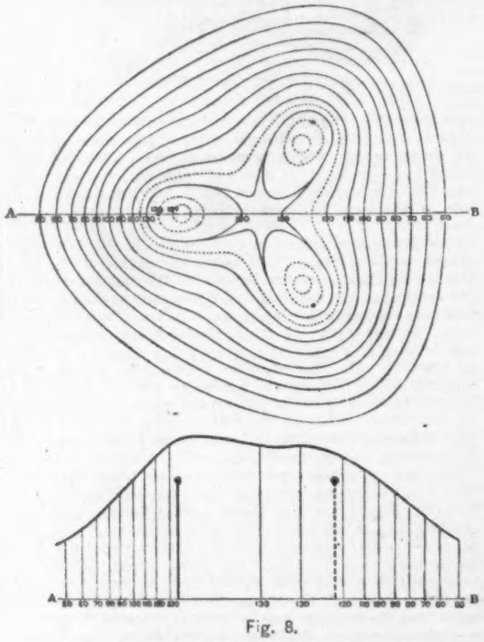

Fig. 8.

radiation in different directions and the shadow cast by the lantern not being considered. The contour lines for lamps at a greater distance apart are very similar to those shown in Fig. 7, and always consist of more or less circular curves, surrounded by hour-glass shaped curves which pass into more or less elliptical curves. It will be noticed in Fig. 8 that the points of maximum illumination are not under the lamps and that within the triangle the illumination does not vary more than 10%.

Figs. 9 and 10 show curves for arc lamps, similarly spaced to the lamps in Figs. 7 and 8, plotted from an average curve of illumination determined by actual measurements.

Illumination Curves.—The author is still rather doubtful as to the best ratio of the vertical scale to the horizontal scale for plotting the illumination curves of the type shown in Figs. 3, 4, 5 and 6. To assume both the height of the lamp and the maximum illumination as unity ceases to be useful when the maximum has an arbitrary or accidental value as in arc lighting. At angles of incidence greater than 55° it has already been shown that the illumination from an arc lamp on a horizontal plane practically varies as the fourth power of the cosine. The maximum illumination in practice is at an angle of about 45°, and $\cos^4 45° = 0.25$. If, then, it is assumed that the maximum illumination measured on a vertical scale equals 0.25, the height of the lamp, the illumination curve will correspond as nearly as practicable with the ideal curve.

Contour Lines.—While the illumination curves show the distribution of light along a given line, they do not show the distribution over a whole area, as do the contour lines in Figs. 7, 8, 9 and 10. In plotting these a uniform difference should of course be assumed between adjacent contours.

Characteristic Curves.—A third method of graphically expressing illumination is by characteristic curves, which somewhat resemble a steam engine indicator diagram. The ordinates show the illumination and the abscissas the areas illuminated, while the total area of the diagram shows the total illumination, just as the area of an indicator diagram shows the total power developed. The maximum and minimum illuminations may be seen at a glance, and the shape of the curve shows the regularity of the distribution of the light. The area illuminated to any given degree may be easily found. Fig. 11 shows a characteristic curve plotted for the simplest possible case, a single lamp emitting light uniformly in all directions. The curve differs from the cosine-cubed curve (Fig. 2) only in the horizontal scale, the former being the square of the latter, but reduced to a convenient length.

Photometry.—After describing several types of photometers for measuring intensity of light, or candle power, the author took up the subject of photometers for measuring illumination. Prof. Weber was the first to make and use an illumination photometer. Prof. Mascart made a somewhat similar instrument with which he made numerous photometric tests of illumination in Paris. In 1883 Mr. W. H. Preece described his illumination photometer before the Royal Society, and a year later a modification was designed by the author in conjunction with Mr. Preece.

After an interval of about 8 years the author again took up the study of illumination photometry and invented a modified form of instrument designed to take measurements as near the ground as possible. Fig. 12 illustrates this instrument. The source of light is an incandescent lamp of ¾ c. p., furnished with current by four storage battery cells which are capable of furnishing a steady light for about ten hours. The lamp has a slightly higher candle-power after charging, but about 15 minutes' use reduces it to the normal rate. The lamp is lighted for as short a period as possible, about 10 seconds being sufficient for each reading. The sliding scale of the ordinary photometer is in this instrument replaced by a reflector turning about an axis. The amount of light reflected varies about as the cosine of the angle of incidence of the beam. The inclination of this reflector is adjusted by a snail-shaped cam which spreads the divisions of the scale more evenly than would otherwise be the case. The scale is empirically calibrated with a standard candle. We abstract the paper further as follows:

Results of Measurements.—The principal object of the measurements made by the author was to ascertain the nature of the distribution of light in various streets and public places and find the amount of the illumination in candle-feet.

While the observed distribution of illumination was found to agree very closely with the general results which might have been arrivd at by calculation, the real point of importance for the engineer who has to carry out the lighting of a given street or building to know is, what degree of uniformity is desirable for a particular case; how that degree may be attained by the proper planting of lamp posts, and the selection of the proper height for such posts. It seems that 0.03 candle-foot is the lowest illumination that should be reached in well lighted streets.

In the South Kensington Museum the Sculpture Court is lighted by Brush arc lamps placed at a height of about 50 ft. The court is 135 × 60 ft., with an 83-ft. ceiling. The illumination is quite sufficient for the artists who sketch there in the evening. The photometer showed 0.5 to 0.8 candle-feet, with 6 to 8 arcs in sight. In the Silversmiths' Court, the illumination was found to be 2.6 candle-feet, with 10 arc lamps in sight. In the gallery over this court about 3.5 candle-feet was recorded.

Charing Cross station is lit by arc lamps about 18 ft. from the platform. The maximum illumination was

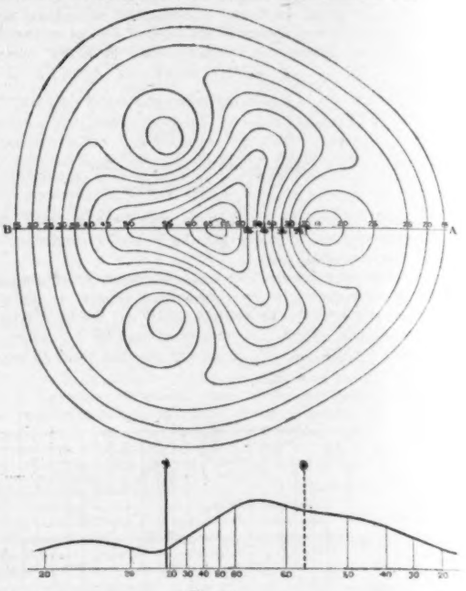

Fig. 9.

found at 15 to 22 ft. from the point below the lamp, and varied from 0.4 to 0.5 candle-foot. The minimum was about 0.05 candle-foot. There are 14 arc lamps in the station and about 646 sq. yds. of floor space per lamp. At Cannon St. station there is about 1,740 sq. yds. of floor space per lamp. The lamps are hung about 35 ft. from the platform and the illumination is from 0.025 to 0.35 candle-foot, distinctly less than at Charing Cross, but the greater height of the lamps prevents the glare found in that station.

On Feb. 11, 1892, a survey of Whitehall St. was made and the contour lines of illumination are shown in Fig. 13. The small lamps are of 90 c. p. and the large

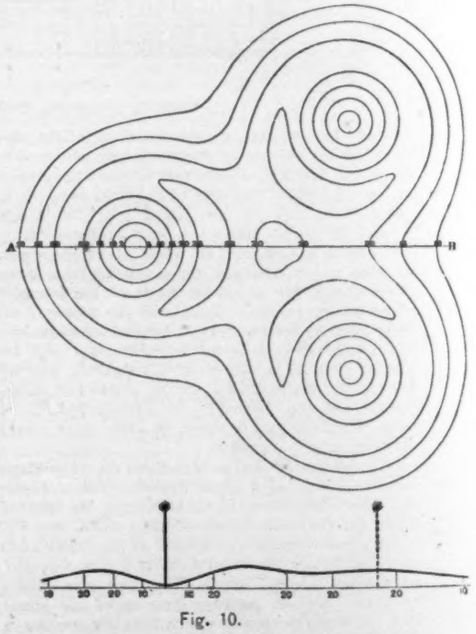

Fig. 10.

lamps are of 270 c. p. The large lamps at the "refuges" are provided with reflectors, which greatly lessen the shadow directly beneath the lamp.

Fig. 14 shows the illumination curves along various lines, plotted from the curves shown in Fig. 13. At the time the measurements were made the moon was nearly full and the sky was cloudless. The dotted line represents the illumination of 0.025 candle-foot due to the moonlight. Fig. 15 is the "characteristic" curve of the illumination in Whitehall St.

Discussion.

Mr. W. H. Preece said the great problem before engineers was how to distribute light uniformly and evenly over the surface upon which they worked. The arc lamp gave an extremely bright and silvery light, but it was too intense for the eye to look at; the incandescent lamp gave a light equivalent to the best gas burners. The light from these lamps was better measured in terms of energy expended to produce it than by the candle power of the light. The arc lamp gave a candle power for every half watt of energy expended; the incandescent lamp gave a candle power for every four watts of energy. In large halls, railway stations and similar places sufficient illumination would be given with an expenditure of ½ watt per sq. ft. of floor space. In the South Kensington Museum a number of beautiful little objects required an intense light and 2 watts per sq. ft. was allotted. In the reading-room of the National Library in Dublin 1 watt per sq. ft. was given and the result was highly satisfactory.* In each of the above three cases arc lights were used. In private houses where a soft uniform light is what is wanted, he would distribute incandescent lamps to give 1 watt per sq. ft. of floor space.

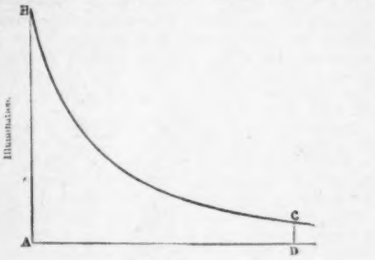

Fig. 11.

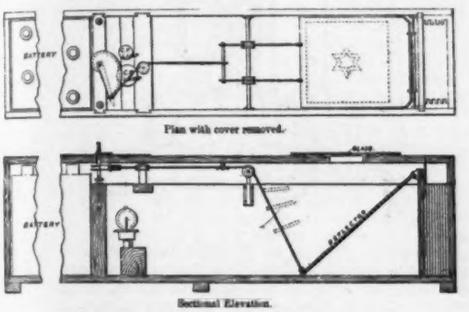

Fig. 12. The Trotter Photometer.

The moral Mr. Preece drew from Mr. Trotter's paper was that for effectual street lighting they wanted smaller arc lamps placed closer together. At no place in Europe is the electric lighting so efficient as in Florence and Milan, where arc lamps are suspended over the centers of the streets, about 25 ft. high and 80 to 100 ft. apart. Speaking of the absorption of light by the glass globes, taking clear glass as unity, mediæval rippled glass absorbed 22% of the light, opal glass absorbed 23%, and ground glass, most used of all, absorbed no less than 46%.

Dr. W. E. Sumpner, speaking of the reflection of light, said that ordinary light colored walls reflected about 50% of the incident light. This doubled the total illumination, for suppose a 100 c. p. light were placed in a room, then the walls reflect back 50 c. p. But this reflected light strikes the walls and 50% is again reflected, thus the sum of successive reflections in an infinite series is equal to the original incident light.

Mr. Gisbert Kapp described the lighting of a factory in Berlin where delicate mechanical operations were carried on. Arc lamps cast too strong a shadow. Incandescent lamps were too much exposed to breakage. The problem was solved by suspending arc lights in large funnel shaped covers, whitewashed inside, which reflected the light against the whitewashed ceiling. The whole room was thus filled with a soft diffused light and work could be done as well by night as by day. He criticised Mr. Preece's figure of 1 watt per sq. ft. as the necessary expenditure of electric energy for arc lighting. He would have set it at ¼ watt per sq. ft., but the character of the walls made a vast difference with the amount of light required.

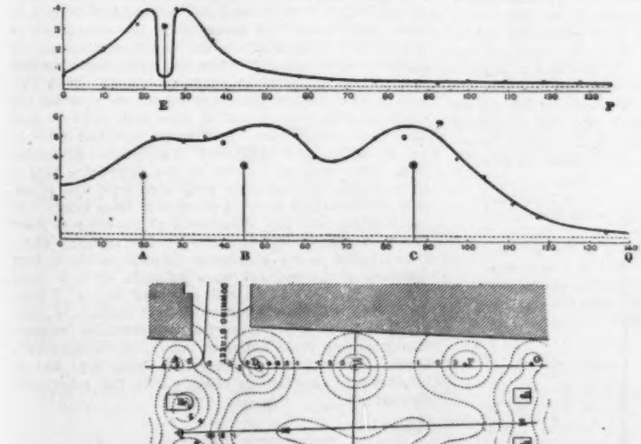

Fig. 14.

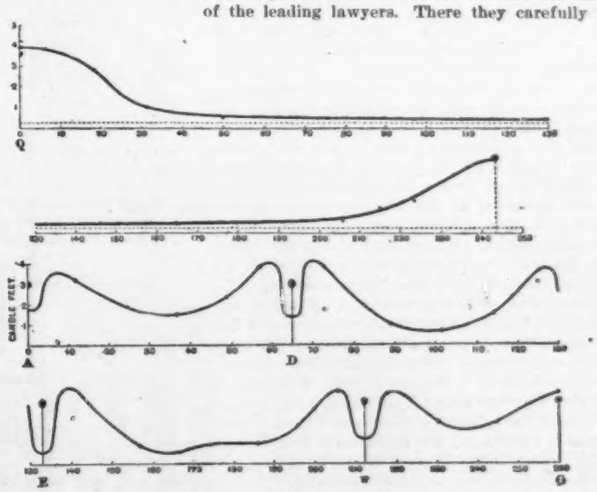

Fig. 13.

*Since 1 HP. = 746 watts, 1 watt per sq. ft. = $\frac{1}{33}$ HP. per sq. ft. = 0.134 HP. per 100 sq. ft., or 1.34 HP. per 1,000 sq. ft. Since half this amount is considered by Mr Preece sufficient for lighting large spaces under roof, we have 0.67 HP. per 1,000 sq. ft. as the expenditure of current necessary for such lighting. Making an allowance for loss of energy in engine and dynamo, we have three-fourths of a horse power per 1,000 sq. ft. of space as the size of power plant required for lighting large interior spaces with arc lamps. But in Mr. Gisbert Kapp's discussion further on, ¼ watt per sq. ft. was stated to be nearer the average amount of current required. This would give a little less than 0.4 HP. per 1,000 sq. ft. of floor space; but far less illumination than this is often made to suffice. The Cannon St. station noted above, for instance, has one arc lamp (size not stated) to 15,660 sq. ft.

SOME REMINISCENCES OF EARLY RAILWAY ENGINEERING IN NEW ENGLAND.

By Edward Appleton, C. E.*

The first charters for steam railroads in New England were granted in 1830 and 1831, for roads leading from Boston to Lowell, to Worcester, and to Providence. These were opened for use in 1835, and soon proved themselves of such great advantage over former means of transportation, that other communities became eager to avail themselves of the new method.

There were not a great many civil engineers in the country at that time. There were no scientific schools attached to the colleges then to give instruction in the studies appropriate to such a profession, and the few who practiced it had educated themselves. West Point, to be sure, gave some instruction in engineering, but it was with reference to military objects rather than to any calls for the purposes of ordinary civil life.

Still, the graduates of West Point were often called upon to attend to works of construction that were entirely devoid of any warlike purpose.

Some fifteen years before this time the Erie canal was opened for use, and was speedily followed by others in various parts of the country, among them the Middlesex canal in Massachusetts, from Boston to Lowell, which had begun to do a fair amount of business when the railroad was opened between the same points, and soon absorbed all the business of its predecessor. Other canals were also built in New England, but most of them have fallen into the same state of "innocuous desuetude" as the Middlesex.

Besides building these canals, our civil engineers of that day had work to do in building dams and factories to make use of the water power of our streams and rivers. But there was no call then for water-works for our cities and towns, nor for comprehensive and well designed sewerage. So if the civil engineers of the day were not numerous, the calls for their services were not extensive, demand and supply balancing each other as in other matters.

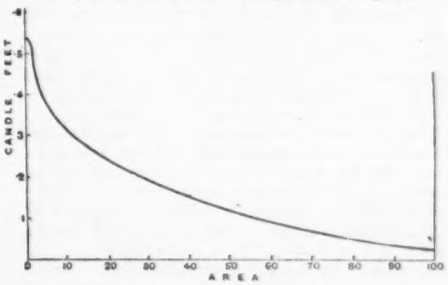

Fig. 15.

But the advent of railroads brought quite a change. The seniors in the profession had more calls than they could personally attend to, and needed many assistants. The new branch of the engineering profession had many attractions for active enterprising young men, especially for new graduates of the colleges. As there were no schools for them to attend, they entered themselves as students in the offices of the heads of the profession, just as students of law entered the offices of the leading lawyers. There they carefully reviewed their college studies of algebra, geometry, trigonometry, and the use of logarithms, read what books on engineering subjects the meager libraries of the day contained, and calculated for themselves tables of excavation and embankment, curve deflections, and such others as they thought would prove useful in practical work. In a few months they found positions on the railroads their principals had in charge, and were sent into the field.

Surveying instruments were not plenty in those days. There were some clumsy theodolites and levels, but scarce any railroad transits, and none

*For the benefit of our readers we would explain that Mr. Appleton, now 76 years of age, and residing at Reading, Mass., is a civil engineer of many years' experience, and was a member of the first Board of Railroad Commissioners of Massachusetts.

of these instruments were equal in finish and accuracy to those of the present day. Moreover, their meager pay did not allow the young men to furnish themselves with the costly instruments, and the corporations thought themselves generous if they provided one set for the whole road. Many a time a party started out to survey a line of railroad, provided only with a common compass to take the bearings of the line occasionally, a level and rod, three or four sighting poles, and the heavy 12 lb. iron chain of those days. Yet with this meager supply of tools they did good work. In running through a wooded district, I sometimes amused myself, when a big tree stood right in the line, by endeavoring to place the sighting pole on the further side of the tree in the true line while the axemen were cutting the tree down. Not infrequently I succeeded, and when the tree was down the pole did not need to be moved. My axemen finally protested that it was of no use to cut a tree down, for I could see right through it. Curves were run in by measuring deflections at each hundred feet. I have known more than on instance of a railroad built upon a line run in this way, which proved sufficiently accurate to lay the track upon and which has been in service ever since. But my sight has grown dim, and I fear I could not now run a straight line by sighting poles even on an open level plain.

In those days, cheapness of construction was the main object sought for, and we looked as carefully for a place to cross a traveled road at grade as we should now for a place to go under or over it. In masonry, we were not expected to plan ordinary abutments with quarried and dressed stone laid in courses. That was reserved for the few prominent and important bridges. The more common ones, such as those for road and farm crossings and small streams, were laid up of ordinary field stone roughly dressed into shape. But we had the work carefully done, and abutments of this sort built 60 years ago are still standing, and are good for 60 years more. For bridges we used Towne's plank lattice and Howe's truss. Iron bridges did not come into use till a generation later. Some plank lattice bridges, built after my own plan, were in use for over 30 years, carrying engines and trains of double the weight for which the bridges were originally built. Rails of 40 lbs. per yd. were considered strong enough, and were so for the engines and cars of those times. Grades were limited to 40 ft. per mile, as it was doubted if an engine could be built powerful enough to haul a train up a much steeper ascent. Most locomotives of that day were 15 tons weight; one of 20 tons or over was thought extraordinarily large, and of doubtful advantage, being too heavy for the track. New England was well settled, and we did not need to camp out. Our quarters were at the country towns, and sometimes at farmer's houses.

There was a fascination then as now about railroad surveying, fully equal to the hunter's or angler's pursuits, and, for myself, I remember my early railroad surveying as the happiest period of my life. In the 40's, railroad surveys and surveyors were somewhat of a rarity and it was the usual thing for the inhabitants to follow the party all day long, as small boys now follow a circus. The humorous side was not wanting; as when our Chief Engineer, in his red Canada leggins and fur cap, was mistaken for an Indian chief by the awe-stricken grangers; or when the talkative axemen, who did not know a logarithm from a T-square, explained that the distance across a wide stream is obtained by measuring right down-stream and the problem solved, "By logarithms, you darned fool."

THE DAIMLER PETROLEUM MOTOR.

There is in this country a large field for light motors which do not require a permanent plant such as steam boilers, etc. The Priestman petroleum engine was described in our issues of Nov. 17, 1888, and Sept. 1, 1892, and we illustrate this week the Daimler petroleum motor which is adapted for launches, stationary engines, road and street railway locomotives, etc. It is a German invention and is being introduced into England by Simms & Co., of Billiter St., London. A number of launches have been built and a light railway motor is in use at the Krupp gun works to carry the officials to the firing ranges. The following cuts and description are taken from the "Mechanical World," of London. Fig. 1 is an end view of a stationary motor; Fig. 2 shows the burner, and Fig. 3 is a longitudinal section of a two-cylinder motor for boats. The oil used is termed "petrol," and is rectified petroleum or benzine. It is of 0.68 to 0.7 specific gravity.

In Fig. 1, A, is the vaporizing chamber in which vapors are generated by means of the suction of heated air through the oil; a little more air is added through

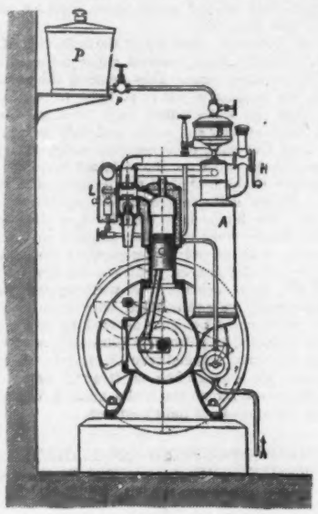

Fig. 1.

the regulating valve H before entering the cylinder, thus producing the proper combustible gas. When the piston descends it draws in some of this gas and air mixture, which is compressed on the return stroke, and the mixture is fired on coming into contact with the red hot inner end of a hollow platinum percussion cap G at the moment when the piston is at its highest point. The lamp with the cap G is shown in Fig. 2. This cap is kept at a red heat by means of the lamp L. The burning gases in the cylinder expand and give a downward pressure on the piston, the motion being transmitted to the crank by a connecting rod in the usual way. To set the motor in operation the vaporizing chamber A and the lamp supplier B must be filled with petrol. This is accomplished in stationary motors by opening the valve p, when the oil flows from the tank P to the lamp supplier and the vaporizing chamber A. An indicator attached to a float is arranged in this chamber, to show the height. In

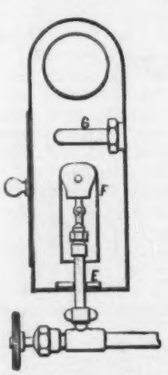

Fig. 2

launches, however, the oil is pumped into the two chambers by means of a small hand-pump, according as required. Before starting the motor, the lamps for heating the percussion caps G are lighted, after the thumb-screw valves at the bottom of the burner have been opened. The burner tube E is previously warmed for about a minute with a spirit light so as to cause the development of the gases necessary to produce an effective flame. This flame, both in and above the burner cap F, burns with a roaring sound, and causes the percussion cap to remain red hot. The wicks in the burner are renewed as occasion may arise, and the working cylinders are lubricated by means of drop oil cups, while the starting crank, the guides and bearings of the main shaft are also kept well oiled. The starting of the motor is done when it is out of gear. As soon as the percussion caps are red hot, the regulator valve H is opened slightly more than half way. The crank handle J, Fig. 3, is then turned quickly once or twice to the right, when the motor, drawing in the explosive mixture, which is fired, as already mentioned, starts; the crank handle is automatically put out of action as soon as the motor is properly running. The exhaust passes through tubes into the atmosphere. The regulating valve H is opened more or less until the right speed is obtained.

The combustion chamber of the cylinder is surrounded by a water jacket, through which water is circulated by means of a force pump, to cool the cylinder; and in the case of the launch, a pulsometer pump was used. From Fig. 3, will easily be understood the working of the launch motor, K being the operating lever or reversing handle, and T R C and S a set of cones for the forward and reverse working of the engine. Before the motor is turned by hand, the reversing handle

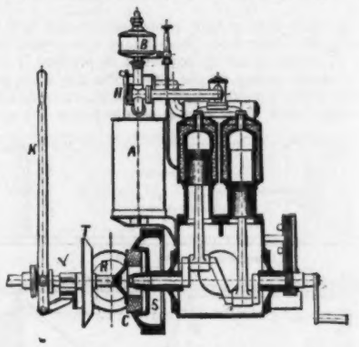

Fig. 3.

is placed in the center so that the shaft is out of gear; the moving of this handle forward or towards the motor puts the shaft in forward gear, while the moving of the handle toward the stern puts it in reverse gear.

NEW PROCESS FOR THE PURIFICATION OF IRON AND STEEL FROM SULPHUR.*

In September, 1890, I commenced a series of experiments with a view of removing the sulphur from iron, being impelled to this research by the recognition of the fact that sulphur was the worst enemy and the only one over which the iron and steel manufacturer had not as yet obtained complete control. With this fact in view I made some experiments to ascertain the effect of prolonged contact of lime with sulphury iron at a high temperature. The results obtained were of an irregular and imperfect description. Reasoning from these results, I came to the conclusion that a more readily decomposable body than lime was necessary for the rapid removal of sulphur from iron. Recognizing the fact that chloride of aluminum and other chlorides are readily reducible to the metallic state, I determined to try if calcium chloride acting in this direction might not act upon sulphide of iron more readily. Whether calcium is produced or not, I soon discovered that calcium chloride and lime, i. e., the oxychloride, is a very powerful desulphurizing reagent. The following table indicates clearly the comparative results obtained, the sulphury iron being kept molten in plumbago crucibles in contact with the substances named:

Molten iron in contact with the mixture. Hours.	Sulphur in iron—Before treatment. Per cent.	Sulphur in iron—After treatment. Per cent.	Mixture.
2¾	0.38	0.03	Lime.
1¾	0.30	0.12	Lime.
½	0.42	trace.	Lime, 90%; calcium chlor., 10%.
½	0.42	trace.	

These results show; 1, that lime alone removes a considerable quantity of sulphur from iron if the contact is sufficiently prolonged;2, that a mixture of calcium chloride and lime in the short space of half an hour completely eliminated the sulphur; further, the lime and the chloride of calcium mixture only softened, but did not fuse. It is upon these last experiments that my process has been elaborated. It consists essentially in bringing chloride of calcium and lime into contact with molten iron or steel under certain well-defined conditions. Before proceeding to describe these conditions it will be desirable to give some information on the important subject of chloride of calcium. The salt is produced as a by-product, to the extent of many

* Abstract of a paper by E. H. Saniter, read at the Liverpool meeting of the Iron and Steel Institute.

thousands of tons, in the manufacture of ammonia, soda (by the ammonia process), and Weldon's bleaching powder process. At the present time not more than 10% of this large quantity is utilized, the remainder running to waste for want of a market. The driest calcium chloride obtainable at present contains 70% calcium chloride and 30% of water, and costs about $10 a ton. Before using it is generally desirable to dry it, and this may easily and cheaply be accomplished in a reverberatory furnace at a low heat, the whole of the water of calcium chloride being driven off at a temperature of 200° F. Calcium chloride may also be cheaply produced by mixing "waste pickle" or similar liquors with lime, and utilizing the mixture of calcium chloride, oxide of iron and lime in the basic open-hearth furnace. Fluor spar in conjunction with lime has considerable desulphurizing properties, but it has also some considerable disadvantages, viz., its comparative infusibility and the severe cutting action which it has on the lining when used in furnaces lined with basic material.

In the process as applied to the removal of sulphur from raw or cast iron. A mixture of calcium chloride and lime is prepared, which will fuse readily at the temperature of the iron to be operated upon. The desired combination is made by grinding calcium chloride and lime together in a mill to thoroughly mix them, and also to bring them to a moderately fine powder. About equal parts of each are required to give the desired fusibility. This mixture is then placed on the bottom of a ladle or receiver, and consolidated by heat or kept in position by other suitable means. The heat may be applied in the first instance by means of a blowpipe arrangement, using blast-furnace gas, but when in continuous use the heat of the ladle itself is quite sufficient. The receiver is then filled with iron, which may be drawn direct from the blast furnace, the heat of which melts the mixture, which, rising up through the metal, removes the sulphur very completely. A reducing atmosphere is not necessary, and, indeed, oxidation may be going on concurrently with the removal of the sulphur, as will be seen later on. Notwithstanding this, however, the sulphur is removed as sulphide. Should it be desirable to remove silicon as well as sulphur, the lime of the mixture is replaced by hydrate or carbonate of lime, or even oxide of iron in addition, should these first be insufficient. About 25 lbs. of chloride of calcium and an equal weight of lime per ton of iron have been found sufficient to effect purification. In the many trials made, about three tons of iron direct from a blast furnace were treated in a ladle at each operation. Although the first or coldest iron from the furnace and hydrate of lime in the mixture were used, no skull was made, which is a fact of the very greatest importance, and there can be no doubt that if such a small quantity of metal is not materially chilled, we may safely assume that larger masses would never skull. The uniformity of the results obtained was very marked, as will be seen by the accompanying analyses:

Class of iron.	Sulphur. Before.	Sulphur. After.	Silicon. Before.	Silicon. After.	Mixture.
	%	%	%	%	
No. 5 hematite	.220	.060	1.6	1.2	Chloride of calcium and hydrate of lime
Hard f'ge 1.5% phosphorus.	.300	.060	1.7	1.4	
Gray forge	.070	.008	2.2	1.6	
Basic iron	.197	.072	Not Estimated		
Basic iron	.190	.062	Not Estimated		
Basic iron	.109	.031	Not Estimated		
Basic iron	.102	.092	.56	.32	
Basic iron	.065	.026	.84	.46	
Basic iron	.090	.016	.32	.09	
Basic iron	.089	.024	.42	.18	
Basic iron	.083	.020	.37	.09	
Basic iron	.133	.030	.70	.32	
Basic iron	.691	.026	Not Estimated		Chloride of calcium and limestone.
Basic iron	.060	.068	Not Estimated		

Nos. 7 to 13 are consecutive charges, and show the regularity of the results. It should be stated that the results obtained above were from the application of the process when it was well known from the appearance of the cinder that the resulting pig would be abnormally high in sulphur. The above table shows an average elimination of 73.6% of sulphur, and 35.77% of silicon, the removal of silicon being due to hydrate of lime only. The following is an average slag produced by the above treatment:—

Calcium chloride	30.1	per cent.
Calcium sulphide	5.8	"
Lime	38.6	"
Silica	12.9	"

A considerable part of the chloride of calcium in this slag may be dissolved out with water, and recovered for future use. Only a limited quantity of iron (about 50 tons), has been treated in this way, owing to proper plant not being as yet available, the small 4-ton ladle being only a makeshift. The ladle was lined with ordinary fire bricks, which were practically unattacked by the slag at the comparatively low temperature at which the process was conducted. Appliances are in course of construction which will deal with the whole output of the furnace as the metal is run. The plant required is of a simple and inexpensive character, consisting of ladle or receivers on wheels. The cost of materials at present prices is about 12 cts. per ton of iron treated, and this will be less when a more efficient receiver is used. It is also very probable that should a demand arise for chloride of calcium the price would go down. Against this extra cost may be set the cheaper production and enhanced price of the pig iron produced.

This process can be adapted to the purification of hematite, basic and common (1.5% P.), irons as they run from the blast furnace or cupola, thus producing these qualities of iron low in sulphur and silicon, after which they might be used for direct steelmaking or cast into pigs; and to the purification of steel in the ladle, after it leaves the furnace or converter. It is a fact pretty well known and established that no sulphur is eliminated in the "basic open-hearth" process as ordinarily worked, and that not only is this the case, but when ore containing much sulphur is used for feeding the bath of steel takes up sulphur, so that under these circumstances is may contain twice as much sulphur as that in the pig and scrap originally used. This is shown by Wedding,* and is confirmed by my own experience. In my process, however, as applied to the basic open hearth, sulphury iron and mineral may be used, and not only is the sulphur not increased in the steel, but a very considerable elimination takes place. In order to attain this result it is necessary at an early period after the charge is melted to obtain an exceedingly basic slag, and to add a suitable quantity of calcium chloride to it. By a very basic slag I do not mean what has hitherto been considered as such, but a step in advance of that, with about 50 to 60% of lime. If these conditions be obtained and maintained it will be found that sulphur is eliminated along with the carbon and phosphorus, and in a satisfactory manner. The best method of obtaining this condition of slag is to charge along with the metal and scrap a much larger proportion of limestone than usual, about 224 lbs. to the ton. When the charge is melted the slag will be of the required composition, and the chloride of calcium may then be added in several lots at intervals. The quantity of 70% chloride used is slightly under the 56 lbs. on the ton of ingots made. The following table shows the quality of iron which has been used and the steel made from it:

	Pig Iron Used. Si.	S.	P.	Mn	Average per cent. of sulphur in metal charged.	Steel Made. C.	Si.	S.	P.	Mn
	%	%	%	%		%		%	%	%
1	0.04	0.76	1.3	0.18	0.58	0.215	Trace	0.081	0.027	0.68
2	0.10	0.45	2.1	0.50	0.35	0.20		0.072	0.052	0.75
3	0.10	0.45	2.1	0.50	0.35	0.19		0.048	0.054	0.59
4	0.04	0.25	2.6	1.00	0.20	0.08		0.048	0.025	0.43
5	0.20	0.23	2.6	1.00	0.19	0.17		0.048	0.045	0.57
6	0.20	0.22	2.6	1.00	0.18	0.145		0.063	0.042	0.73
7	0.20	0.22	2.6	1.00	0.18	0.20		0.063	0.045	0.61
8	0.40	0.22	2.5	1.30	0.18	0.18		0.018	0.031	0.40
9	0.20	0.17	2.6	1.20	0.14	0.15		0.038	0.040	0.58
10	0.18	0.16	3.1	1.50	0.13	0.13		0.032	0.040	0.21
11	0.44	0.15	2.5	1.50	0.13	0.75		0.042	0.040	0.60
12	0.20	0.15	2.6	1.00	0.13	0.15		0.038	0.040	0.58
13	0.65	0.13	3.3	1.30	0.11	0.155		0.025	0.035	0.68
14	0.56	0.05	0.05	3.00	0.05	0.115		0.016	0.010	0.12

The pig used in the above charges was 7.50%. These analyses have been selected to show the varying percentages of sulphur in the cast iron used and the different grades of steel made. No. 10 is conductivity steel. No. 14, made from white hematite, is Swedish bar quality. The Wigan Coal & Iron Co. has now manufactured over 2,000 tons of steel, of which the above are examples, wrom sulphury iron, the process being continually and successfully worked by this company. The company has been sold for all purposes for which basic open-hearth steel is used; wire, hoops, rivet-steel, tin bars, etc., and has been found to be fully equal in quality to that made from pure cast irons. It is evident from what has been said that no great care is necessary in the selection of materials, the only objectionable elements being silica and silicon. The commonest descriptions of iron scrap and ore may be used subject to the above reservation. The yield of ingots obtained is as good as that in the use of low sulphur iron. The use of common iron high in sulphur and low in silicon and carbon has the advantage that a less quantity of steel scrap is required, and that the consumption of ore for feeding is reduced very considerably. The cost of the chloride of calcium is about 25 cts. per ton on the weight of ingots, but owing to the saving effected in the cost of materials and in the quantities of scrap and ore used, there is in reality a saving of about $1 per ton of ingots. Neither the hearth or brick work of the furnaces nor the regenerators are in any way effected by the use of calcium chloride, as has been proved by practical experience over a period of six months.

* Journal of the Iron and Steel Institute, part II., p. 547.

SEWER GAGINGS AT TORONTO, ONT.

The following figures regarding the flow of sewage at Toronto, Ont., in the spring of 1891, are from the last annual report of the city engineer. Mr. W. T. Jennings, C. E., was city engineer when the gagings were made, Mr. G. C. Cunningham, M. Inst. C. E., when the report was compiled, and Mr. E. H. Keating, C. E., now holds that position. The gagings, so far as can be judged from the report, extended through one day, only. The last column has been added for convenience.

Sewer Gagings at Toronto, Ont.

	Size of sewer.	Area drained above weir.	Population., Per acre.	Population., Total.	Discharge in— Cub. ft. per minute.	Cub. ft. per acre per min.	Cub. ft. per head per day.	Cub. ft. per day.	Galls. per head per day
7	ft. 6 ins. diam.	2,485	15.7	39,014	278.09	.11	10.27	400,450	77
3	" 6 " × 5 ft. 0 ins.	372	46.2	17,186	212.28	.57	17.78	305,683	133
3	" 9 " × 2 " 6 "	360	8.8	3,168	31.80	.09	11.07	45,072	83
2	" 0 " × 3 " 0 "	13	44.0	572	16.74	1.29	42.14	24,105	316
2	" 6 " × 5 " 0 "	101	45.5	4,595	32 65	.32	10.23	47,016	77
2	" 0 " × 3 " 0 "	25	41.8	1,045	10.89	.43	15.00	15,682	113
3	" 9 " × 2 " 6 "	350	17.6	6,160	57.40	.16	13.44	82,800	101
3	" 9 " × 2 " 6 "	263	42.3	11,125	71.56	.27	9.26	103,046	69
3	" 8 " × 4 " 0 "	160	39.8	6,368	67.20	.42	15.19	96,768	113
2	" 6 " × 5 " 0 "	195	42.4	8,268	62.62	.32	10 90	90,166	89
4	" 6 " diam.	740	11.8	8,732	82.25	.11	13.56	118,440	102
6	" 6 " × 5 ft. 0 ins.	225	43.7	9,832	80.83	.36	11.84	116,395	99
3	" 8 " × 4 " 0 "	271	41.7	11,300	70.94	.26	9 04	102,153	68
2	" 4 " × 3 " 6 "	770	9.4	7,238	70.57	.09	14.04	101,616	105
2	" 6 " × 5 " 6 "	311	45.7	14,213	117.10	.38	11.86	168,624	89
0	" 3 " diam.	503	38.3	19,265	93.78	.19	7.02	135,043	53
	Averages	...	24.0	..	...	.200	11.62	.....	87
	Totals	6,794	...	118,081	1,...0.50	....	.....	1,953 061	..

*Estimated from assessments of 1890 and census of 1891.

THE SPECIFICATIONS FOR THE NEW YORK CITY RAPID TRANSIT R. R.

(With inset.)

The franchise for the New York City Rapid Transit Ry. confers on the company obtaining it the right to build a railway about 17½ miles long with a total trackage of about 62 miles. Its general route is from the Battery up Broadway and the Boulevard and thence north across the Harlem River to the city limits, with a branch from Union Square north to the Grand Central Station. The portion of the East Side route from this point north, which was shown in the Commission's former report, has been abandoned. The terms of sale of the franchise are fully stated and commented on elsewhere. Most of the drawings accompanying the specifications are practically the same as those published a year ago and are but little fuller in detail. The engineering staff of the commission has, however, designed several structures of very creditable appearance for the upper portion of the line which we shall show in a following issue. A plan and elevations of the City Hall station are given on our inset sheet.

From the lower terminus to 121st St., a distance of about 8½ miles, the line will be entirely underground, and located generally as near the street surface as it is possible to come without interference with the gas and water pipes and other subsurface structures. The side walls of the tunnel are to be generally of stone masonry or of stone masonry faced with brick. The roof is flat, consisting of three-ring brick arches turned between steel beams, which are supported on the

side walls and steel columns, set between the tracks. The double-track loop at the southern terminus (Fig. 6) is to be built with a concrete invert at the bottom, subgrade at this point being below high-water mark. We find no mention in drawings or specification of this method of construction being required elsewhere. From the Battery loop to Vesey St. a three-track tunnel is specified, as shown at Fig. 5, p. 392 of our issue of Oct. 24, 1891. Similarly for the section of the four-track tunnel under Broadway above Chambers St. see Fig. 6, p. 392 of that issue. Fig. 3 of that issue shows a map of the single-track loop at City Hall Park. This loop line will cross underneath the main tracks at Mail St. The cross section of the tunnel under the Boulevard from Sixtieth to 108th St. was shown on Fig. 8 of the same issue. The section of the East Side branch from Seventeenth to Thirty-third St. is practically the same as that of the Broadway line, and the same thing is true of the Boulevard line from 108th to 121st St., 135th to 155th St., 160th to 161st St., and of the line under Eleventh Ave. from 178th to 185th St. The section of the East Side branch from 33d St. to 42d St. under the existing horse-car tunnel is shown on Fig. 1 of our inset sheet.

The other sections of the Boulevard line are in open cut, or on viaduct, according to the contour of the surface. From 121st to 123d, 134th to 135th, 155th to 156th and 158th to 160th Sts. the tracks will be carried in a depressed way between retaining walls, the section being shown in Fig. 2. A viaduct of ornamental design carries the line across Manhattan Valley. From 161st to 178th St., and from 185th to 190th St. the line will be in an arched roof, four-track tunnel, the section of which is shown in Fig. 3. At 190th St. the four-track line terminates and two tracks only are to be built from that point to the northern terminus. They will be in tunnel, in open cut, with retaining walls, either elevated or depressed, or on embankments or viaducts, as the contour of the surface may require. The upper part of the line is still so sparsely settled that ordinary earth cuts and embankments can be used to a considerable extent.

The location of the stations on the line is to be as follows. Stations where express trains will stop are denoted by an asterisk:

Station.	Total distance, miles.	Station.	Total distance, miles.
Battery	0.	97th	7.1
Wall	0.5	110th	7.8
Cortlandt	0.7	122d	8.4
Chambers*	1.0	Manhattan*	8.7
White	1.4	135th	9.0
Grand	1.7	145th	9.5
Bleecker	2.1	156th	10.1
8th	2.5	169th*	10.7
14th*	2.8	181st*	11.3
23d*	3.2	Fort George*	11.9
29th	3.5	King's Bridge Road	12.7
34th	3.8	220th	13.2
42d*	4.2	Riverdale Ave	14.0
50th	4.6	Spuyten Duyvil Parkway	14.5
60th*	5.1	Riverdale Lane	15.2
72d	5.8	Stewart's Lane	15.9
79th	6.2		
86th	6.5		

There will also be stations on the City Hall Park loop at the Brooklyn Bridge entrance, and on the East Side branch at 23d, 33d and 42d Sts., the last an express station.

Concerning the manner of construction, the specifications require all parts of the main line below 34th St. to be built by underground tunneling and "without disturbing the surface of the street." The same thing applies to the East Side branch under the Fourth Ave. horse car tunnel. It is provided, however, that in case of necessity the excavations below Beaver St., and near Canal St. may be made from the surface and at other special points, which the Commission may determine the same thing may be done. Above 34th St. and on the East Side branch below 34th St. the excavations may be made from the surface at pleasure.

Of course the company must assume the risk of injury to buildings and foundations along the line, move gas and water pipes, etc. only under the supervision of the Commissioner of Public Works, and replace the street surface in as good condition as when found. The use of explosives must be in conformity with the city ordinances and with such special regulations as may be made.

Drains are to be provided along the whole length of the tunnel leading to sumps, where pumping plants will be located lifting the water to sewers. One or more footways must be provided for the whole length of the lines and refuge niches must be built in all depressed and tunnel parts of the line.

Rails are to weigh not less than 75 lbs. per yd. and guard rails or guard timbers must be provided over the whole line. The ties, the ballast and the method of constructing the permanent way must be "of the best description for the transportation of the traffic." The best and most efficient system of block, switch and train signals must be adopted and constructed, and a telegraph system must be erected connecting all passenger and signal stations. Products of combustion must be excluded from the tunnel and a proper and sufficient system of ventilation must be introduced. We quote further from the specifications as follows:

The cars must be propelled by electricity, or by some form of power not requiring combustion within the tunnel. The motor must be sufficiently powerful to readily start a train of eight cars, each weighing, in addition to its load of passengers, not less than 30,000 lbs., on a 1½% grade, and the motor must also be able to maintain the same train at a speed of not less than 40 miles per hour on a level gradient. Should each car be provided with its own motor, such motor must be capable of exerting sufficient power to comply for each car with the above requirements.

Each car must be provided with arrangements for heating and with full and proper arrangements for lighting. Each car must have ample and comfortable seating capacity for the number of passengers to be carried by the car.

All cars must be made in the most substantial manner, and be provided with the best wheels, brakes, trucks and other appliances.

Each station must be provided with suitable waiting and toilet rooms, with all proper conveniences for the use and comfort of passengers. The platforms and stations and the stairways, hallways, galleries, approaches and passages must be of ample size for the accommodation of passengers and must be provided with full and proper arrangements for lighting every part to be used by passengers, and for heating such parts as should be heated. The arrangements for the entrance and egress of passengers to and from platforms and to and from cars must be such as to provide for comfortable and speedy accommodation of passengers to the full extent of the capacity of the railway.

Wherever the vertical distance between the grade of the street and the station platforms exceeds 20 ft., passenger elevators shall be provided. These must be of sufficient number and of ample capacity, of suitably swift movement and must have all proper arrangements for safety and for convenience of entrance, exit and approach from both the street and the station platform.

The regulations for operating the road shall in all respects be such as shall be approved by the Rapid Transit Railroad Commission.

It is understood that under these plans and specifications a railway is to be built of the best possible construction and having the highest efficiency. The constructing company must therefore use materials and provide workmanship of the best quality, and shall as far as possible introduce an artistic effect, so that the stations, waiting rooms, platforms, cars, columns, girders, roofs, walls and other visible portions shall have a pleasing appearance. All steel, iron, rails, ties, wood, stone brick, cement, concrete, mortar, glass, paint and other material used in the construction of the railway shall in their respective ways conform to the best standard of excellence and be subject to tests and inspection approved by the said Commission.

The Rapid Transit Railroad Commission shall have supervisory charge of the work during its construction, and at any time during its progress the said Commissioners, their engineers, inspectors, or other duly authorized agents shall have full access to all parts of the work and to the inspection of all material delivered or about to be delivered, which is to be used in the work. Any work which, in the judgment of the Rapid Transit Railroad Commission, is not in accordance with these plans and specifications or others which may be issued or approved during the progress of the work, shall immediately be made good, and all material condemned as unfit for use shall be removed within such time as the Rapid Transit Commission may order. If the constructing company shall use any method of construction which the said Commission shall deem as unsafe, or as not giving the best possible result, the said Commission may in its judgment order such method stopped or altered, and the constructing company must obey such orders immediately.

Although the said Commission will supervise the work of construction, nevertheless such supervision shall not relieve the constructing company from any liability whatsoever.

The construction of the railway must begin within four months after the acceptance of the bid for the franchise, and the whole line must be completed and in operation within five years from the commencement of construction. The portion between City Hall and Fourteenth St. must be in operation within two years; the whole system south of Fifty-ninth St., including the East Side branch, must be in operation within three years; and the portion from Fifty-ninth St. to the Harlem River must be in operation within four years from the commencement of work.

LEAD COATED METAL PLATES.

From experiments thus far made, says an exchange, it would appear that the new process of coating iron and steel plates with lead is likely to inaugurate an important industry. The plates or other articles to be coated are first pickled in a bath to remove scale, and through this bath a weak current of electricity is passed, which is said to reduce the time required by one-third. From this bath the articles are passed, as usual, into another of lime water, which neutralizes the acid, and thence into a third of clear water; they are then immersed in a fourth bath, consisting of a neutral solution of zinc and stannic chlorides, obtained by dissolving granulated zinc and tin in hydrochloric acid; and from this bath they are passed into a drying chamber, heated by steam, where the moisture on them from the last bath is evaporated, leaving behind a deposit of the mixed metallic chlorides, which protects the plates, etc., from oxidation, and, when dried, these plates are ready to be passed into a bath of molten lead. On issuing from the bath, the plates are found to be coated with a uniform and very adherent layer of lead, and, though perfectly uniform, the layer is nevertheless very thin. The ductility and strength of the iron are not diminished by the process, and a plate can be bent and closed, and again opened out, without breaking the coating. In the case of galvanized iron, bending the plate to a sharp angle causes the coating to crack.

The railway system of Italy is owned chiefly by the government, and is operated by private companies under lease, for which they have paid to the government $50,000,000, and have agreed to give in addition 27½% of the gross earnings. The passenger rates are as follows on express trains: First class, 4 cts. per mile; second class, 2.8 cts.; third class, 2 cts. For accommodation trains the rates are rather lower. There were 8,161 miles of railway in operation in 1890, not including steam tramways, of which, in January, 1891, there were 1,574 miles. The number of persons employed was 99,685. The gross earnings of the companies in 1890 amounted to $49,979,948 and the net earnings were $16,706,953. The cost of the roads averages between $43,400 and $50,000 per mile.

The telegraph system of Italy is almost entirely owned and operated by the government, with the exception of the lines belonging to the railway companies, operated by them for their own purposes and in some cases for private business. The ordinary messages are sent at a fixed rate of 20 cts. per 15 words or less, including the address. Urgent telegrams have the precedence over all others and are chargd 60 cts. for the same number of words. These rates are the same throughout the entire kingdom, no matter what the distance. The number of employees in 1890 was 7,511. The gross earnings of the system in 1890 amounted to $3,010,974, and the expenses to $2,703,137, leaving a net earning of $307,837. The aggregate length of wires was, in 1890, 83,270 miles. The number of telegraph offices operated by the railway companies in 1890 was 1,507. About the only criticism made in Italy upon the present telegraph system is that the tariff is considered rather high, which applies equally to the postal system; but the economic and financial conditions of the country are such that a reduction is not easy.

The sewerage and sanitation of the city of Calcutta, India, have been reviewed in a paper by Mr. H. J. S. Cotton, noted in "Indian Engineering." The underground drainage system was commenced in 1850, and the total expenditure incurred on the work up to March 31, 1890, was about $3,700,000. The number of premises connected with the sewers is 25,938. There are 37 miles of main or brick sewers, and 147 miles of pipe sewers. The enormous improvement effected by the obliteration of the old open drains and the substitution of underground drainage may still be partially realized by a visit to the suburbs of the town, where open drains still exist. A survey for the systematic drainage of the suburbs is now in progress.

The Beira Railway Co. has been incorporated in London to build a line from Beira, on the southeast coast of Africa, across Portuguese territory to the eastern frontier of British territory, opening up communication with the coast for the Mashonaland gold fields and the British and Portuguese territory north of the Transvaal. The line will be 2-ft. gage, 180 miles

long, and contracts have been made for constructing the first section of 75 miles. The engineers are Sir George W. Bruce and Sir Charles Metcalfe.

A competitive test of cut and wire nails is probably to be made at the Watertown Arsenal, called out by the conflicting claims of the makers of the two classes of nails. The annual output of these two makes of nails is equal to about 9,000,000 kegs. An association of prominent manufacturers has issued a circular to wire nail makers asking them to be represented at a test to commence Nov. 30 and to be conducted under the supervision of the commanding officer of the Arsenal on the Government testing machine. The chief object is to ascertain the comparative holding power of cut and wire nails of equal length and weight when driven into some common building wood.

The Russian cruiser "Rurik," just launched, is claimed to be the longest ironclad in the European navies. This vessel is 435 ft. long, 67 ft. beam and 25 ft. 9 ins. depth, with 10,933 tons displacement. The "Sardregna" of the Italian navy is 410 ft. long and was previously the longest cruiser in the world. It is said that the "Rurik" can steam from Cronstadt to Vladivostock, 19,000 miles, without coaling on the way.

The Santa Anna incline cable railway, at Genoa, Switzerland, has been opened for business. It is of the single track type, with a central turnout, and is carried its entire length by a masonry viaduct. Its total length is 1,180 ft., with a difference in elevation between terminals of 183.4 ft. The grades vary from 14% to 19½%. The cars have a seating capacity of 16 persons, and are equipped with both hand and automatic brakes. The cable for operating the line is of steel, 1 in. diameter.

Relief cars, equipped with medicines and surgical appliances for use in case of accidents, etc., are maintained on the State railways, and some other railways, in India.

Progress is being made toward securing a new water supply for Albany, N. Y. On November 15 Mr. Clemens Herschel, M. Am. Soc. C. E., and Mr. J. J. R. Croes, M. Am. Soc. C. E., the experts retained by the Board of Water Commissioners, appeared before the Board with reference to the project for procuring an additional supply of water from Kinderhook Creek. They gave it as their opinion that the source of supply as proposed by Mr. Elnathan Sweet, C. E., President of the Board, was ample and that the scheme for impounding the water and conveying it some 25 miles to the city of Albany appeared to be perfectly practicable and that the location of the impounding reservoir was so favorable that detailed examinations and estimates of cost of the dam and of the conduit line to the city should be prepared as soon as possible. It is stated that the record of gagings of the flow of the stream made under Mr. Sweet's direction show the drainage area to be an unusually retentive one, capable of furnishing a uniformly large flow in dry seasons.

Railway drawbridges with somewhat clumsy machinery, are in operation in England, according to descriptions published in the "Railway Press," of London. The London, Chatham & Dover Ry. has a double bridge for railway and roadway traffic over the river Swale. The company charges toll on everything that passes over, and the signalman collects the toll. The total length of this bridge is about 400 ft., and the part that opens is 60 ft. long, and weighs 150 tons. This part opens into two parts from the center, so that when the bridge is open, the two parts stand on end, nearly upright. With the machinery provided, it takes eight men to raise it. The work is done by the trackmen on the two sections near the bridge. There is a high post erected at the signal box, on which is an iron ball, worked by a pulley. When a vessel wants to pass through the bridge, the signalman pulls this ball to the top of the post. This can be seen by the two gangs of platelayers on any part of their length; and they go at once to the bridge. The Great Eastern Ry. has a bridge between Wivenhoe and Brightlingsea, which is swung round so that when open it is parallel with the stream. There is a wooden guard pier to protect each end of the open bridge, so that vessels passing through shall not damage it. Th's bridge swings round on iron balls running in a groove. The balls are kept well blackleaded, so that they run easily. There are two men kept at the bridge, and they have to open and close it when required. One man can work the bridge. The rule was that every train had to stop at the entrance to the bridge; and the man in charge had to ride over on the engine. An English railway drawbridge of modern construction was illustrated and described in our issue of Sept. 15.

The North River Bridge Company proposes to raise the sum of $100,000,000 on a somewhat peculiar plan. The redemption scheme has been called a lottery by one of the holders of the securities, and the case has been tried before Judge Truax, of the Superior Court, and the redemption method is declared valid. The plan proposed is as follows: The company to issue $100,000,000 in bonds of $100 each, to be secured by a trust mortgage. The mortgage was to provide for the redemption of bonds before maturity. The bonds are to be payable in the year A. D. 4343, and to draw interest at 6% annually, 2% to be paid semi-annually and the remaining 2% at the maturity of the bonds, 2,450 years hence. It is intended that a sinking fund shall be established for gradual redemption. This is to be made up of $500,000 deposited with the trustee of the mortgage before each interest day, and also a sum equal to the semi-annual interest, 2%, on all bonds previously redeemed. The bonds to be redeemed are to be designated by the trustee by lot one month before the bonds are redeemed. They are to be redeemed "at their maturity value," and this language is construed by the directors to mean that each bond is to be redeemed by the payment of $5,000, such amount being arrived at by taking the principal of the bond, $100, and adding to it items of the annual interest at 2% for 2,450 years.

The Interstate Commerce Commission has just issued an important decision in which the long and short haul clause of the law is construed in the light of over five years of its operation, and of decisions by the Commission and by English and American courts. Under this decision the carrier has the right to decide whether he may charge more for a short than a long haul when the "dissimilar circumstances and conditions" are wholly upon its own line or when they arise through the competition of carriers not subject to the law (water routes, foreign railways, or railways within a single state). Of course any person injured may bring suit before the Commission and have the legality of the carrier's action reviewed. In all other cases of supposed dissimilar circumstances the carrier must not charge more for a short than a long haul until he has obtained permissive order from the Commission.

The contract for two turbines for the Niagara water power plant has been awarded by the Cataract Construction Co. to the J. P. Morris Co., of Philadelphia, Pa. The contract calls for two superimposed turbine wheels of 5,000 HP. each, to cost in the neighborhood of $100,000. They are to be set up and in operation eight months from Nov. 1. They will be built after the designs of Messrs. Faesch and Piccard, of Geneva, Switzerland. Each wheel is composed of two superimposed turbines, supported on a hydraulic pivot. The water is fed between the wheels in conduit pipes and the discharge is exterior. The largest turbines hitherto are of 2,000 HP. The wheel pits now in process of construction are 18 ft. wide, 140 ft. long and 160 ft. deep. The company is constructing wheel pits for three wheels, and another will be added to these just ordered. The contracts for the dynamos will be let within 60 days.

The purification of Hamburg water is the problem engrossing the attention of the authorities of that city. The present population of over 500,000 consumes about 31,700,000 gallons of water daily, or about 63 gallons per head. Driven wells are proposed for a "fairly good service," and Dr. Werner Siemens recommends the boiling of the present water supply, and the Hamburg Senate is said to be considering his proposition. Dr. Heinzerling, of Frankfort-on-the-Maine, goes into further details, and thinks that some system could be devised in which a large portion of the heat imparted to the water could be utilized again in boiling further quantities of water. Any other method would entail too great expense in fuel, etc. He proposes a countercurrent or induction system. The pipes containing the heated water would be cooled by contact with cold-water pipes, and the latter thus made warm. One difficulty in the way that may be overcome by the use of chemicals, is the presence of large quantities of carbonate of lime in the Elbe water, which would form scale in the hot-water pipes. Dr. H. estimates that the annual cost for fuel, attendance, maintenance and redemption of plant would amount to from 30 to 72 cts. per head of present population. This does not include first cost of the plant, but seems small enough to deserve further investigation.

The relative holding power of wire and of cut nails is to be carefully tested at the Watertown Arsenal on Nov. 30. The test has been brought about by a number of prominent manufacturers of cut nails, and their committee invites the cooperation and criticism of all manufacturers of wire nails to insure the general acceptance of the tests as absolutely fair and authoritative. Mr. Chas. L. Bailey, of Harrisburg, Pa., is chairman of the committee.

The entrance to Honolulu harbor, heretofore accessible only to vessels drawing less than 22 ft., has been dredged to a depth of 30 ft. The work was done by a hydraulic dredge built by the Risdon Iron Works, of San Francisco, at a total cost of about $114,000, of which $65,000 was paid by the Government for the dredges. The present passage is about 200 ft. wide at the bottom and 1,200 ft. in length through the bar.

Manganine is a new German alloy made of copper, nickel and manganese. It is claimed that it has great resisting power, higher even than nickeline, and is very slightly affected by high temperatures. It is especially commended for the manufacture of measuring instruments and electrical apparatus. It is said that used for the latter purpose, unlike other metals, manganine diminishes its resistance as the heat increases.

Tests of ocean currents have been made by the Prince of Monaco and described by him in a paper to the French Academy of Sciences, of which he is a corresponding member. He has for the past ten years been devoting himself to experiments with a view

ELEMENTS OF WEATHER IN THE UNITED STATES OF MOST INTEREST TO ENGINEERS FOR THE MONTH OF OCTOBER, 1892.

[Furnished to Engineering News by the Department of Agriculture.]

	Station.	Temperature. (Deg. Fahr.) Average	Max.	Min.	Range.	Wind. Velocity miles per hour. Average	Max.	Direction at time of max. velocity.	Precipitation—(Rain and melted snow)—inches. Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	44.3	72	21	51		42	N	1.52	0.33	18
	Portland, Me.	48.0	72	33	39	7.8	28	NW	1.64	0.46	9
	New York City	55.4	79	39	40	10.5	34	SW	0.63	0.29	7
	Pittsburg, Pa.	54.0	78	33	45	6.4	36	NW	0.51	0.19	7
	Chicago, Ill.	53.6	80	32	48	17.0	58	NW	1.54	0.78	6
	Omaha, Neb.	57.4	87	28	59	6.3	30	NW	1.28	0.66	5
	St. Paul, Minn.	51.2	83	24	59	10.7	44	NW	1.39	1.09	6
	Duluth, Minn.	49.0	78	29	49	8.2	34	N	0.38	0.16	4
	Bismarck, N. Dak.	49.2	86	17	69	8.8	44	NW	0.86	0.72	4
	Average	51.3	79.4	28.4	51.0	9.1	38.9	.....	1.08	0.52	7
Southern Cities.	Washington City	55.4	84	30	54	6.1	34	W	0.34	0.33	3
	Louisville, Ky.	58.8	85	32	53	4.6	25	SW	0.86	0.64	6
	St. Louis, Mo.	60.2	87	32	55	9.5	30	W	1.66	0.41	5
	Savannah, Ga.	66.1	85	40	45	7.3	26	NE	1.12	0.61	4
	Leavenworth, Kan.	58.4	86	32	54	7.4	36	NW	2.80	1.29	5
	Jacksonville, Fla.	69.2	88	42	46	6.9	24	NE	3.34	2.01	10
	Chattanooga, Tenn.	61.4	85	31	54	3.9	17	SW	0.29	0.12	3
	New Orleans, La.	71.0	87	48	39	9.6	50	NE	2.14	1.80	6
	Memphis, Tenn.	64.4	86	35	51	6.4	23	SE	0.62	0.40	3
	Palestine, Tex.	69.2	89	40	49	5.6	25	N	5.74	3.82	9
	Average	63.4	86.2	38.2	50.0	6.7	29.0	.....	1.88	1.14	5
Western Cities.	Helena, Mont.	47.2	78	26	52	7.7	34	SW	0.26	0.12	5
	Port Angeles, Wash.	48.2	64	33	31	4.2	24	W	1.33	0.56	10
	San Francisco, Cal.	59.6	79	47	32	6.7	36	W	1.65	0.91	6
	Salt Lake City, Utah	51.8	80	30	50	5.1	37	NW	1.58	0.44	10
	Denver, Colo.	50.2	90	29	61	7.4	18	NW	3.92	2.58	4
	Yuma, Ariz.	72.2	100	42	58	5.7	32	N	0.00	0.00	0
	Santa Fé, N. Mex.	48.8	77	21	55	7.7	45	SW	1.32	0.37	9
	Average	54.0	81.1	33.0	48.1	6.4	36.6	.....	1.44	0.71	6

to ascertaining the speed and direction of the currents of the North Atlantic. He has had upward of 1,760 large bottles, encased in a thin copper covering, thrown into the sea at different points between the continent of Europe and America. Of this number 226 have been returned to him by the governments of the various countries to whose shores they had drifted. Their progress has been noted with sufficient accuracy to lead to the conviction that the movement of the upper part of the ocean is in a circular direction, the center being somewhat to the west of the Azores. The tide of the Atlantic thus descends the coast of Africa, and, running toward the west, flows almost to the island of Bermuda. It then turns eastward. The speed at which the bottles traveled is estimated at an average of 4 miles in 24 hours, though at some points a rate of 6 miles in 24 hours was attained. The rapidity is greatest in the western half of the circle thus described. Several of these bottles immersed as far back as 1886 have been presented to the academy, their copper coverings almost completely corroded by the action of the salt water.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

TIONESTA VALLEY & HICKORY.—It is expected that grading will be completed on this line from Nebraska to Ross Run, Pa., 5 miles, by Dec. 1. Pres., T. D. Collins, Nebraska, Pa.

LEHIGH VALLEY.—It is expected that the Geneva & Van Ettenville R. R., from Van Ettenville to Geneva, N. Y., will be opened for business on Dec. 4.

ORFORD MT.—Work is being rapidly pushed on this line from Eastman to Kingsbury, P. Q., and it will soon be ready for business. Contractor, G. C. Foster, Montreal, P. Q.

TERRE HAUTE & INDIANAPOLIS.—A press dispatch from Muskegon, Mich., says: "It is announced here that the Vandalia system, the northern terminus of which is now at St. Joseph, Mich., will soon be extended to this city, taking in all the Lake Michigan shore towns on the way. From Muskegon a line of boats will run to Milwaukee, reaching out after the Northwest business. The proposed line will parallel the Chicago & West Michigan road.

CANADIAN PACIFIC.—Tracklaying has been begun on the 26-mile branch, from Renfrew to Eganville, Ont.

OHIO SOUTHERN.—This company has let the contract for the extension of its line south from Wellston, O., to a connection with the Columbus, Hocking Valley & Toledo R. R., to P. R. McLaughlin & Son, of Columbus, O. Contracts for 62 miles of the Springfield-Lima line have been let to McArthur Bros., 820, Tne Temple, Chicago, Ill., and to P. R. McLaughlin & Son. Work has already been begun on the line south from Wellston, and will begin this week on the Springfield-Lima line. Subcontracts will be let.

IRON RANGE & HURON BAY.—This railway has been completed from Champion to Huron Bay, Mich., 35 miles, and surveys are in progress for an extension to Ishpeming, Mich., 18 miles. The new work will be comparatively light, and it is expected to have the entire line open for traffic by Aug. 15, 1893. Consult. Engr., Milo Davis, Detroit, Mich.

WABASH.—The grading is completed, and 121 miles of track have been laid on the line from Montpelier, O., to Hammond, Ind., 148.1 miles.

Projects and Surveys.

MONTREAL & PACIFIC JUNCTION.—This company has been reorganized to build a railway from Hochelaga, P. Q., via Bout de L'Ile, to a point on the Canadian Pacific Ry. near L'Assomption, P. Q. Surveys are to begin at once. Pres., A. Desjardins; Ch. Engr., J. P. Casgrain, both of Montreal, P. Q.

SOUTHBRIDGE, STURBRIDGE & BROOKFIELD.—Bids will be received until Nov. 30 for the grading, masonry and bridge work on this railway from Brookfield to Southbridge, Mass., 13 miles. Ch. Engr., Arthur C. Moore, Southbridge, Mass.

INDIANA, ILLINOIS & MICHIGAN.—The right of way has all been secured for this railway from Michigan City to Hammond, Ind., and it is stated that construction will begin at once.

Southern.—Existing Roads.

OWENSBORO, FALLS OF ROUGH & GREEN RIVER.—At a recent meeting of the stockholders of this company it was decided to authorize the issue of $6,000,000 of bonds, the proceeds of which were to be used in the construction of a line to Middlesborough, Ky.

CAPE FEAR & YADKIN VALLEY.—A short branch will be built to the quarries of the Carolina Brown Stone Co., office Sanford, N. C.

TREDGAR MINERAL.—This company has built one mile of track in the town of Jacksonville, Ala.

MONTGOMERY, TUSCALOOSA & MEMPHIS.—A press dispatch from Tuscaloosa, Ala., dated Nov. 14, says: "Pres. Woolfolk, of the Montgomery, Tuscaloosa & Memphis R. R., and President Clark, Superintendent McLaren, and Chief Engineer Farrar, of the Mobile & Ohio, arrived here to-day, and will leave to-morrow on a tour of inspection of the Montgomery, Tuscaloosa & Memphis road, which has been nearly completed between Tuscaloosa and Montgomery. It is rumored that the Mobile & Ohio people will join President Woolfolk in building the road, which will be extended on to a connection with the Mobile & Ohio, at Columbus."

ARCADIA, GULF COAST & LAKELAND.—The contract to build an extension 6 miles long, from Manatee, Fla., to a point on the Alafia River, connecting with the Florida Central & Peninsula R. R., has been let.

JACKSONVILLE, ST. AUGUSTINE & INDIAN RIVER.—Surveys are in progress for an extension south from Rock Ledge, Fla., to Melbourne, Fla., 24 miles. Ch. Engr., Chas. O. Haines, Titusville, Fla.

Projects and Surveys.

CHATTANOOGA TERMINAL.—This company has applied for a charter to build a railway from the Central Depot, Chattanooga, Tenn., west across the Tennessee River, on a bridge which it intends to build, and thence through Hamilton, Marion, Sequachee, Bledsoe and Van Buren counties. Among those interested are: H. H. Webster and Jas. R. Whitman, of Chattanooga, Tenn.

ROCKFORD & CROSSVILLE.—The survey for a railway line from Rockwood to Crossville, Tenn., in the interest of the citizens of the former place, has been completed. A favorable route is said to have been secured.

Northwest.—Existing Roads.

MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE.—President Van Horn, of the Canadian Pacific, is quoted as follows in regard to the extension north from Valley City, N. Dak.: "The extension begins at Valley City, 287 miles from Minneapolis, and will extend through the counties of Barnes, Stuttsman, Foster, Wells, Church, McHenry, Ward, Renville and Montraille, in North Dakota, or about 200 miles to the Canadian Border, to which point the Canadian Pacific will build from Regina, Man., about 200 miles, and this completed there will be formed the shortest line from Minneapolis and St. Paul to the Pacific Coast. The new line crosses the Great Northern at Minot and the Northern Pacific at Carrington. We expect to reach the latter point this year, and complete the extension by August or September of next year."

WISCONSIN CENTRAL.—It is rumored that this company is making arrangements to secure terminals of its own at Milwaukee, Wis., with a view of building from that city to Chicago.

GREEN BAY, WINONA & ST. PAUL.—An official of this company is reported as saying that all the preparations had been made to extend its line from near Alma Center, Wis., to St. Paul, Minn., 113 miles. The locating surveys have been completed.

Southwest.—Existing Roads.

CHICAGO, ROCK ISLAND & PACIFIC.—The tracklaying south of Red River is still in progress, and it is expected that the rails will be laid into Bowie, Tex., about Dec. 1. Trains will probably be running into that town by Dec. 15. It is about 24 miles south of the Red River and 128 miles south of Minco, I. T., which was the terminus of this line at the beginning of the year. All but one of the engineering parties on the extension have been disbanded, and no preparation has been made to do any work on the line south of Bowie this winter. It is not even known whether the location south of that point has been adopted, but that the line will be extended south toward Fort Worth or Dallas is confidently believed.

HOUSTON BELT & MAGNOLIA PARK.—This company has been authorized to issue receivers' certificates to liquidate all valid claims against the company, and to provide for an extension of its road.

KANSAS CITY, NEVADA & FT. SMITH.—A force of about 200 men and 100 teams are at work on the extension from Hume, Mo., to Pittsburg, Kan. The grading between Hume and Clayton is nearly completed, and track has been laid as far as the Osage River.

Projects and Surveys.

CALCASIEU, VERNON & SHREVEPORT.—The locating surveys for this railway north from Westlake, La., are in progress, and as soon as they are completed, contracts for grading about 15 miles of the road will be let. Engrs., Shutts & Burton, Lake Charles, La.

ARKANSAS CONSTRUCTION CO.—This company has been incorporated in Arkansas to build, construct and equip railways under and by contract with railroad companies or other persons in Missouri and elsewhere; to buy, own, hold, sell, mortgage, lease or otherwise dispose of real estate and franchises. The capital stock of the company is $500,000, divided into 5,000 shares, of $100 each. The shareholders are George Mathews, R. A. Smith, Albert P. Simpson, all of Kansas City. These three shareholders constitute the Board of Directors.

Rocky Mt. and Pacific.—Existing Roads.

PORTLAND & PUGET SOUND.—A press dispatch says: "The many settlements made by President Clark, of the Union Pacific, to the effect that work on the Portland & Puget Sound branch would be resumed, will in all probability, soon be realized. It is stated on good authority that a party of engineers of the Great Northern are en route to Portland to relocate the line. The Union Pacific has expended over $2,000,000 on this line in surveying, grading, etc., and it is understood that the Great Northern will complete the road and it will be operated jointly by both companies. The line will be relocated immediately, and work will be pushed during the winter. The Great Northern will be completed to Seattle within 30 days, and there will be no stop there. The army of laborers the company has gathered with great difficulty will then move on to Portland."

Projects and Surveys.

FLORENCE, CRIPPLE CREEK & STATE LINE.—It seems probable that work will soon begin on a portion of this proposed railway from Florence, Colo., to Cripple Creek. Already preparations are being made to begin work on the long bridge over the Arkansas River, near Florence, and it is stated that orders will be placed for ten miles of steel rails with the Pueblo Steel Works.

NEVADA SOUTHERN.—It is announced that locating surveys are being made for a line from The Needles on the Atlantic & Pacific R. R., north 30 miles, into Nevada, to open up mines.

CALIFORNIA NORTHEASTERN.—This company has been chartered in California to build a standard gage railroad from Anderson, in Shasta Co., to a point on the Sacramento River, in the same county, thence across the river by ferry, and from there northerly to Section 17, township 32 N., 3 W. The articles also state that it is proposed to extend the road in a northeast direction to a point in township 34 N., range 1 W., in Shasta county. The length of the road will be about 40 miles. The incorporators are Joseph E. Barry, Solomon Bloom, Edward B. Young, Marcus D. Hyde, James Spiers and Will H. Smith. The capital is $200,000, of which $39,500 has been actually subscribed.

ELECTRIC RAILWAYS.

BROOKLYN, N. Y.—The Atlantic Avenue R. R., which has recently put in the overhead wire electric system, has been acquired by a New York syndicate, and the Brooklyn City R. R., which has also put in that system, has also been acquired.—The park authorities have refused to allow the overhead wires to be strung along the Plaza, in spite of the Aldermen's permission, and propose to require the wires to be laid underground.

ORANGE, N. J.—The Newark Traction Co. has applied to the Council for permission to extend its lines.

REYNOLDSVILLE, PA.—The Reynoldsville & Rathmel Electric Street Ry. Co. has been incorporated; capital stock, $25,000, with $5,000 paid in. Pres., F. K. Arnold.

ASHLAND, PA.—The Ashland, Locust Dale & Centralia Ry. Co. has been organized to build an electric road; capital stock, $40,000, with $12,000 paid in. Pres., Joseph F. Bailey, 720 North 20th St., Philadelphia.

ATLANTA, GA.—The East End dummy line will be equipped for electric traction, probably by the Short system. The track is being relaid with 50-lb. rails and ballasted with gravel.

CHICAGO HEIGHTS, ILL.—The Pennington & Fuller Electric Co. has been incorporated to build an electric railway and furnish light; capital stock, $1,500,000; incorporators, J. L. McKittrick, Joseph A. Fuller and Lntellers Smith.

DESPLAINES, ILL.—The Desplaines Electric Ry. Co., of Chicago has been incorporated by Willis T. Griffith, S. A. Jacobs and F. E. Brady, with a capital stock of $1,500,000.

PHOENIX, ARIZ.—The Electric Tramway Co. has been incorporated, with a capital stock of $200,000.

HAMILTON, ONT.—The Council has refused to favor the application of the Hamilton, Grimsby & Beamsville Electric Ry. Co. for a bonus of $50,000. It has resolved to offer no objection to the Hamilton, Watertown & Guelph Electric Ry. Co. and the Hamilton Electric Ry. Co., making application for charters of incorporation.

ELEVATED AND CABLE RAILWAYS.

BROOKLYN, N. Y.—The Kings County Elevated Ry. Co. proposes to build a branch to connect with the Brooklyn & Brighton Beach R. R., while the Brooklyn Elevated R. R. Co. proposes to connect with the Prospect Park & Coney Island R. R. and the Brooklyn, Bath and West End R. R.

BALTIMORE, MD.—The City Passenger Ry. Co. and the Baltimore Traction Co. have a considerable portion of the cabling of their roads completed, and expect to have the cable cars in operation by next April.

CHICAGO, ILL.—The City Elevated Ry. Co. has been incorporated to build a line on the South Side.

HORSE AND MOTOR RAILWAYS.

NEW YORK, N. Y.—The Railway Ammonia Motor has been granted permission to run an experimental motor on some street railway.

BRIDGETON, N. J.—The Bridgeton Rapid Transit Co. has been organized to build a line 5 miles long, which will eventually be extended to Millville. Capital stock, $100,000; Pres., Walter P. Douglas, Newark, N. J.; Secy., Walter H. Bacon, Bridgeton, N. J. Gas engines will be used.

LONG BRANCH, N. J.—The West End & Long Branch Ry. Co. has been organized, with a capital stock of $100,000, all paid up, by F. Kuhn, L. Werner and F. G. Loeb, New York, N. Y.

MAHONINGTOWN, PA.—The Mahoning Ry. Co. has been incorporated to build a line to New Castle; capital stock, $150,000; Pres., Geo. B. McLane, Alexandria, Va.,

BOWLING GREEN, KY.—The Aberdeen Coal Co. will build a steam dummy line for freight and passenger service.

HUNTSVILLE, ALA.—W. G. Wells, will build three to four miles of street railway, to be operated at present by horse-power, and later on electricity may be adopted. There will be four cars at first.

STERLING, ILL.—The Sterling & Rock Falls Interurban Ry. Co. has been incorporated by E. W. Jackson, Sheridan Blacke and Robert N. Newton; capital stock, $100,000.

NORTH GREENFIELD, WIS.—The people have raised $6,000 of the $10,000 required by the Milwaukee & Wauwatosa Motor Co. for the extension of its road to North Greenfield, which is to be incorporated as a village as soon as the street railway connections with the city are completed.

LEAVENWORTH, KAN.—The Judson Pneumatic Ry. Co. has been authorized to build a line to Fort Leavenworth, and grading will be commenced shortly. There will be a viaduct across the Kansas Central Ry. The M. C. Bullock Mfg. Co., of Chicago, has been awarded the contract for the manufacture of the motors and running gears of the cars, while the Pullman Car Co. will construct the car bodies. Mr. W. L. Judson will supervise the work of construction, and has effected a change in the automatic charging device. Colonel Graves, the engineer in charge, has purchased ties for the road. Mr. H. L. Earle is one of the promoters.

HIGHWAYS.

IOWA.—The Road Commissioners have made a report to the Board of Supervisors of Woodbury Co. They have subjected to a thorough investigation the work done in each road district under the present system of township road work, and find the same and the present system and practice under which this class of road work is carried on exceedingly defective and insufficient in the extreme. In their judgment there has never been a time when a change in the system of township road work has been more needed than at the present, and they recommend that each township be consolidated into but one road district, and that the township trustees be empowered to hire one man to do and oversee the road work of the township. This has been adopted in Banner township and the condition of the roads there and the amount of road work done show that it is far superior to the old system.

BRIDGES, TUNNELS AND CANALS.

ROCHESTER, N. Y.—It is probable that the appropriation for the Court St. stone arch bridge will be increased to $160,000.

BUFFALO, N. Y.—Bids will be received until Nov. 30 for building a steel arch bridge with stone and brick piers and abutments, and retaining walls over Seajaquada Creek. Edwin F. Bishop, Secy.

TUNNEL.—Competitive plans for a combined tunnel under the Duluth Ship Canal, for the accommodation of steam railway, street railway, wagon and foot travel, will be received by the Board of Public Works, in and for the corporation of the City of Duluth, until

10 a. m., on the 21 day of January, 1893. Data and and specifications in relation thereto are on file in the office of said Board, or will be furnished on application to the undersigned. A cash prize of $1,000 will be paid for the best plan submitted. The principal features of the plans submitted, which will be considered above all others, will be cheapness of construction, durability and adaptability of location. Henry Truelsen, Pres. Board of Public Works.

WATER-WORKS.

New England.

GLOUCESTER, MASS.—Dec. 6 the people will vote on buying the private works.

LOWELL, MASS.—Cy. Engr. Bowers has recommended that driven wells be put down for an additional supply and a 5,000,000-gallon pumping plant established in connection with them.

MILLBURY, MASS.—C. L. Goodhue, Elbridge G. Howe, J. Frank Howe and others, have applied for incorporation as the Millbury Park Forestry & Water Co.

NORWOOD, MASS.—Edward P. Shattuck, M. M. Alden and John Gillooly, Water Commissioners of Norwood, have applied for authority to supply the inhabitants of East Dedham and East Walpole with water for domestic and other purposes.

WEST BROOKFIELD, MASS.—A better water supply is being discussed. There is talk, merely, of extending the North Brookfield system to this place.

HAZARDVILLE, CONN.—At a citizens' meeting, F. W. Parsons, G. H. H. Miner and David Gordon were appointed to petition the next legislature for authority to allow School District No. 13 to put in 13 or more fire hydrants.

WALLINGFORD, CONN.—The sum of $8,000 has been voted for a pumping plant at Muddy River.

Middle.

ALBANY, N. Y.—Engrs. Clemens Herschel and J. J. R. Croes, both of New York, have indorsed Kinderhook Creek, the new source of supply proposed by Engr. Elnathan Sweet, Pres. Bd. W. Comrs. An impounding reservoir and a 25-mile supply conduit are proposed.

ROCHESTER, N. Y.—The Pure Water Co., through Stuart & Sutherland, have offered the city a temporary supply of 4,000,000 gallons daily for five years at 10 cts. per 1,000,000 gallons, water to be taken from Irondequoit Creek and delivered into the Mt. Hope reservoir.

YONKERS, N. Y.—It is expected that the Grassy Sprain reservoir will be enlarged by the construction of a new dam and also that a reservoir will be built into which water will be pumped.

JERSEY CITY, N. J.—Only one formal bid for a new water supply was presented Nov. 21. It was from Moffett, Hodgkins & Clarke, 16 William St., New York City, and offered a supply from the Rockaway drainage area on the following terms: First, 22,000,000 gallons, $40 per million; next three millions, $38; n xt five, $34; next five, $31; all additional, $25. The maximum supply called for is 50,000,000 gallons. Particulars are given elsewhere in this issue regarding the informal bid.

NEWARK, N. J.—Engr. Jacobson has been instructed to prepare plans and specifications for a new storage reservoir. It is reported that it will be built in South Orange and have a capacity of 175,000,000 gallons.

HANOVER, PA.—The people have voted 443 to 360 to buy and enlarge the works of the company.

LEBANON, PA.—The proposed new company intends to supply East Lebanon, a suburb.

McKEESPORT, PA.—Probably bids will be received until Dec. 6 for two 3,000,000-gallon compound condensing direct acting pumping engines to raise water 305 ft. through 1,400 ft. of 16-in. rising main; piston speed not to exceed 90 ft. per minute, with an allowance of 5% for slip, and with an effective steam pressure of 80 lbs. per sq. in. The stroke of the pumps must not be less than 24 or more than 36 ins. A guaranteed duty of 60,000,000 ft.-lbs., based upon a boiler evaporation of 10 lbs. of water per pound of coal. A. Tuskeep, C. A. Walker, Geo. Mars, Water Comrs.

PITTSBURG, PA.—The Citizens' Water Co. has been incorporated to supply the city south of the Monongahela and Ohio rivers; $500,000; commence business with $100,000. Treas., Robt. S. Fraser.

TOPTON, PA.—The Council has received a proposition for works with a supply from a hill south of the town.

Southern.

ROME, GA.—Address Supt. A. J. Wagner regarding proposed improvements, including, it is reported, a 2,000,000 and 3,000,000-gallon reservoir.

LAFAYETTE LA.—Nov. 12 the people voted 50 to 23 against levying an eight-mill tax for ten years for works.

TAZEWELL, TENN.—It is stated that the "County Democrat" will conduct a campaign for works.

ANDERSON, KY.—The people have cast an informal vote of 102 to 18 in favor of works. It is said that the Council will probably make arrangements for a water supply.

North Central.

CINCINNATI, O.—Supt. Tharp has asked the Board to advertise for a 20,000,000-gallon pumping engine, double or triple expansion, and for four vertical pumping engines of 4,500,000 gallons capacity each.

MARTIN'S FERRY, O.—A contract for a new pump and boilers has been awarded to the Hughes Steam Pump Co. for $12,990. The other bids and a description of this plant will be found under "Contract Prices."

READING, O.—The vote for works on Nov. 8 was 424 to 76.

WAPAKONETA, O.—Nov. 8 the people voted 479 to 182 in favor of building works. At a former election the people voted against a franchise.

Northwestern.

DULUTH, MINN.—The Council has passed a resolution declaring its intention to buy the works of the water company, and instructing the clerk to give a year's notice to the company.

Southwestern.

MORRILLTON, ARK.—It is reported that water and electric lighting plants are projected by the American Electric Co., Philadelphia, Fred Balcom, Gen. Man.

Pacific.

PASADENA, CAL.—The Cottonwood Canyon Water Co. has been incorporated; $50,000.

KENDRICK, IDAHO.—It is reported that the town cannot at present raise money to build works, and that a company proposes to build them.

Canada.

NIAGARA FALLS, ONT.—The proposition to lay new mains at a cost of $35,000 was voted down Nov. 15.

PEMBROKE, ONT.—Bids will be received until Dec. 9 for constructing an intake pipe and well, steam pumping plant, water tower and distribution system. Wm. O'Meara, Chn. Water-Works Com.; Willis Chapman, Engr., Toronto.

ARTESIAN WELLS.

TOLEDO, O.—The City Clerk has been instructed to advertise for bids for two artesian wells.

ALAMOSA, COLO.—The Holland-American Land Co. has just closed a contract with M. Packness for from 70 to 100 artesian wells on its farms west of town. The wells will be put down on each 80 acres, and will be from 2 to 6 ins. in diameter.

IRRIGATION.

WOODVILLE, CAL.—The Tule River Irrigation District will receive bids until Dec. 6 for $90,000, 6% bonds, payable in from 11 to 20 years. Pres., J. E. Grimsley; Secy., W. R. Harris.

SEWERS.

WESTBROOK, ME.—We are informed by H. W. Foster, Cy. Engr., that he will not complete the surveys for the proposed system of sewers this season. The city usually appropriates from $2,000 to $5,000 each year, and with this sum sewers are built where most needed.

LENOX, MASS.—The Selectmen have reported that the town of Stockbridge has refused to allow this town to put a pumping station anywhere within the town limits. The Selectmen had previously decided upon land just over the line in the town of Stockbridge for the location of the pumping station. The State Board of Health will be invited to visit the town and suggest how best to dispose of the sewage, and an adjourned town meeting will be held next month to consider the question.

WAKEFIELD, MASS.—The estimated cost of the proposed sewerage system, referred to more fully in our issue of Oct. 20, is $86,887.

PAWTUCKET, R. I.—The Common Council has appropriated $12,000 for sewers in South Woodlawn.

MERIDEN, CONN.—At a special city meeting Nov. 14, $50,000 was appropriated for completing the trunk line of sewers.

SOUTHINGTON, CONN.—The question of a sewerage system, as noted last week, is being considered. The irrigation system of disposal is proposed, and preliminary surveys have been made. The plant is estimated to cost about $30,000.

BROOKLYN, N. Y.—The Commissioner of City Works will receive bids until Nov. 30 for seven sewers.

NEW YORK, N. Y.—The Commissioner of Public Works in Wards 23 and 24 will receive bids until Nov. 29 for sewers in Walnut Ave., between 138th and 141st Sts., and in 173d St., from existing sewer 55 ft. west of Anthony Ave. to Morris Ave.

ROCHESTER, N. Y.—The Common Council is considering the question of a sewerage system for the portion of the city south of the Pinnacle Hills.

SYRACUSE, N. Y.—Three 18-in. tile and one each of 24-in. and 36-in. brick sewers have been ordered.

TROY, N. Y.—The Board of Contract will receive bids until Nov. 29 for a pipe sewer in Third St.

NEWARK, N. J.—The City Surveyor has been instructed to prepare plans for the construction of a system of sewerage for the Woodside district of the old Eighth and Twelfth wards.

PATERSON, N. J.—The Board of Public Works has voted to construct 12 to 15-in. pipe sewers in six streets, and a 30-in. brick sewer in one street.

MEADVILLE, PA.—A resolution to advertise for bids from sewer experts for making sewer maps, plans and details, has passed both Councils.

JACKSONVILLE, FLA.—The proposed main sewer in Bay St. is estimated to cost $40,000.

LE MARS, IA.—Plans for a complete system of sewers will be prepared by Engineer Tschirgi, of the firm of Tschirgi & Kringle, who are at present constructing sewers in the city of Davenport. It is reported that the system at this place will be constructed next spring.

REDLANDS, CAL.—The City Clerk will receive bids until Nov. 30 for sections of storm water ditch, on the Brown-Seymour branch of the Morey Arroyo.

HALIFAX, N. S.—The Board of Works has voted to petition the legislature for authority to spend $100,000 a year during 1893 and 1894, for sewers. The city has been authorized to spend $400,000 for the construction of sewers at a rate not to exceed $80,000 per year, but the present sanitary condition of the city is such that this sum is not deemed sufficient for present use.

STREETS.

ALBANY, N. Y.—The report of Horace Andrews, Cy. Engr., on the proposed Northern Boulevard, to which reference was made last week, is now being considered by a special committee. The estimated cost of construction is as follows: Earthwork, $8,190; macadamizing, $25,912; trees, $750; culvert and inlets, $2,350; inspecting and advertising, $850; viaduct, $60,000; total, $98,052. The cost of repaving with granite or asphalt and of recurbing Knox St., from Clinton Ave. to the north line of Livingston Ave., would be about $18,000.

BROOKLYN, N. Y.—The city has voted in favor of street paving to cost about $50,000. The Commissioner of City Works will receive bids until Dec. 2 for repaving two streets with granite blocks.

BUFFALO, N. Y.—The following lowest bids were received by the Board of Public Works, Nov. 15: Barber Asphalt Paving Co., eight contracts, $108,438; German Rock Asphalt Co., three contracts, $104,214. For paving Box Ave., the German Rock Asphalt Co. bid $44,000 for paving with asphalt; P. B. McNaughton, $56,000, with Medina sandstone; Leonard Hettrich, Jr., $35,580, with brick.

NEW YORK, N. Y.—The Commissioner of Street Improvements of Wards 23 and 24 will receive bids until Nov. 29 for three contracts for grading, curbing and flagging, and one contract for paving with granite blocks.

JENKINTOWN, PA.—The Borough Council has awarded the contract for macadamizing all the streets within the borough limits, except Beechwood Ave., to James Sattherwaite at $20,000. Limestone is to be used, and work will commence at once. Including Beechwood Ave. the contract is $28,200.

PHILADELPHIA, PA.—The Highway Comm'ttee of Councils has recommended appropriations for next year aggregating over $1,000,000. This includes $300,000 for repaving streets with improved pavements, and $300,000 for completing the paving of Broad St. with asphalt.

READING, PA.—At a special meeting of Councils Nov. 16, an ordinance was introduced appropriating $600,000 to pave all the principal streets of the city. It is estimated that over 20 miles of streets can be paved with this sum. The matter will be voted on by the taxpayers at the spring election.

LOUISVILLE, KY.—It is proposed to pave Broadway at an estimated cost ranging from $12,000 to $25,000.

INDIANAPOLIS, IND.—The contract for paving Circle and adjacent streets with asphalt has been awarded to the Western Paving & Supply Co., at prices ranging from $10.15 to $10.69 per lin. ft. The total cost will be about $40,000.

DETROIT, MICH.—The Board of Public Works reports that about 70 or 80 paving contracts have been completed this year, and that specifications are nearly ready for advertising for additional paving, as follows: With cedar blocks or plank, 7 contracts; asphalt, 3; brick, 1; and for asphalting on present stone pavement, 1.

PORTLAND, ORE.—Contracts for paving have been awarded as follows: Oregon Paving & Contract Co., paving Burnside St., $22,407; Portland Bituminous Paving Co., Morrison St., Seventh to Chapman Sts., $40,441; Trinidad Asphalt Co., Morrison St., Front to Seventh Sts., about $30,000.

ELECTRICAL.

THOMPSONVILLE, CONN.—The citizens have voted to contract for 40 arc lights for street lighting at $90 per light per year.

ROCHESTER, N. Y.—The Citizens Light & Power Co., recently organized, has secured from the Common Council the same privileges granted to the other companies. The site of the old Jefferson and Clinton mills, with over 100 ft. of frontage on Brown's race, has been secured, and plans are being prepared for new buildings. Engineer Robt. Cartwright will have charge of the construction of the plant, which it is claimed will be one of the largest in the state.

MONONGAHELA CITY, PA.—The Monongahela City Electric Light Co. is reported as about to double the capacity of its plant.

PHILADELPHIA, PA.—The Councils' Committee on Gas has recommended 911 additional electric lights for next year. The estimated expense of the Bureau of Lighting is put at $857,198 as against $699,566 last year.

TOPTON, PA.—The Council is considering an offer of Isaac Eckert to light the town by electricity.

BALTIMORE, MD.—J. Frank Morrison and T. Edward Hambleton are interested in a projected new company, which, if formed on the basis proposed, Mr. Morrison says, will require a capital of more than $2,000,000 to perfect all the plans and put it on a working basis.

OXFORD, MD.—An electric light plant will be erected by the Bowman's Bazar Electric Light & Power Co.

COVINGTON, VA.—John S. Ham is interested in a proposed plant.

ANDERSON, IND.—The city will invest $35,000 in an electric light plant.

JACKSON, MICH.—A new company has been organized to supply incandescent lights; capital stock, $125,000.

LANSING, MICH.—We are indebted to E. O. Sellers, Cy. Engr., for the following information: The city on Nov. 14 completed the purchase of the plant of the Lansing Electric Light Co., consisting of 6 dynamos, 3 double expansion compound engines, 3 boilers equipped to use either coal or crude oil, 55 miles of wire, 175 commercial arc lights, and 125 street lights, capacity of 1,500 incandescent lamps, and a contract to furnish power for the electric street railway. The cost was $45,000, exclusive of real estate. The Thomson-Houston system is used. The plant will be operated by the Electric Light and Water Board, of which Chas. Connell is president; D. Barcianger, secretary, and Philip Thoman, superintendent. The plant will soon be transferred to the site of the water-works pumping station, and operated in connection with the same.

CHICAGO, ILL.—The Chicago Edison Co. will commence work this week on a new plant to supply light and power to residents of the North Side. The low tension current of 110 volts will be used, and both incandescent light and power can be had from the same wire. The plant will be located on the Newberry Library grounds, and is estimated to cost $500,000. The company's plant at Harrison St. and the river is being pushed to completion. This station will have a capacity of 35,000 HP., and when finished, the North Side power house will be used as a substation, drawing on the main station for an extra supply when needed. Next year the company proposes to erect a plant in the West Side for residents of that part of the city.

CHICAGO HEIGHTS, ILL.—The Chicago Heights Land Association has been considering the feasibility of erecting an extensive electric plant, and it is claimed that such a plant will be put in by the Pennington & Fuller Electric Co., noted elsewhere as incorporated.

OCONOMOWOC, WIS.—At a meeting of the Common Council Nov. 14, a contract for street lighting was awarded for ten years. The company offers to have the plant ready by May next. It is proposed to extend the circuit outside of the city limits around Lac la Belle and the resorts on the shore of Oconomowoc Lake. H. H. Shufeldt is president, and Geo. L. Wilsey secretary of the company.

WINONA, MINN.—The plant of the Winona Electric Light Co. has been purchased by the Northwestern General Electric Co. and will be enlarged and new

buildings erected. The power plant of the electric street railway will be located in the same building.

TUCSON, ARIZ.—An electric light company has been organized and it is probable that the city will soon be lighted by electricity.

ALAMEDA, CAL.—The city plant will be improved at a cost of $6,000.

BERKELEY, CAL.—The Town Trustees have awarded the contract for maintaining the electric light plant during the winter to the Berkeley Electric Light Co. for $350 a month. The company will make improvements in the present plant.

SAUSALITO, CAL.—The Board of Supervisors of Marin Co. has granted a franchise to M. G. Elmore and C. B. Greene, San Francisco, to erect an electric light plant at this place.

NEW COMPANIES.—General Electric Launch Co., Camden, N. J.; $300,000; H. Weston and C. A. Senior, Jr., New York, N. Y., and W. R. Robins, Ozone Parks, N. Y. General Electric, Gas & Iron Co., Jersey City, N. J.; $5,000,000; J. M. Farquhar, Buffalo, N. Y.; T. Gallagher, Belfast, Ireland; A. Vanderbilt, New York, N. Y. Pennington & Fuller Electric Co., Chicago Heights, Chicago, Ill.; $1,500,000; Joseph L. McKitterick, Joseph A. Fuller, Lutellus Smith.

CONTRACT PRICES.

SEWERS.—Boston, Mass.—The Metropolitan Sewerage Commission opened bids Nov. 12 for section 43 of the main sewer, between Cambridge and Somerville. The total length is 14,480 ft.; average depth to 10 ins. below invert, 10 ft.; maximum external diameter, 5 ft.; brick and other masonry, 2,360 cu. yds. The bidders were as follows: 1, Cashman & Juul, Newburyport; 2, H. P. Nawn, Roxbury; 3, James Killian, Brighton; 4, Maney & Gannon, Quincy, Mass.; 5, Mellen & McKenzie, Springfield; 6, Chas. Linehan, Cambridgeport; 7, John Sheehan, Lynn; 8, Chas. G. Craib, Chelsea; 9, Christopher McBride, Brighton; 10, Everson & Liddle, Providence, R. I.; 11, Dennis O'Connell, Dorchester; 12, National Construction Co., Boston; 13, Jones & Meehan, Jamaica Plain; 14, Metropolitan Construction Co., Boston. The items and quantities are as follows: Earth excavation and refill: A, for sewer 35 × 42 ins., 2,700 lin. ft.; B, for sewers 29 × 37, 27 × 35, and 23 × 33 ins., 5,230 lin. ft.; C, for 18-in. brick sewer, 1,380 lin. ft.; D, for 18-in. pipe sewer, 1,400 lin. ft.; E, for 15-in. pipe sewer, 3,690 lin. ft.

Masonry: Brick, American cement, F, more than 4 ins. thick, 1,100 cu. yds.; G, 4 ins. thick or less, 300 cu. yds.; Portland cement, H, more than 4 ins. thick, 500 cu. yds.; I, 4 ins. thick or less, 100 cu. yds.; concrete masonry, J, American cement, 400 cu. yds.; K, Portland cement, 100 cu. yds.

Lumber: L, spruce lumber in place, 15,000 ft., B. M.; M, spruce piles, driven, 2,400 lin. ft.

	Earth excavation and refill					Masonry						Lumber		
	A	B	C	D	E	F	G	H	I	J	K	L	M	Total.
1	$6.60	$5.76	$2.52	$3.41	$3.06	$18.60	$20.50	$24.00	$25.50	$8.40	$9.65	$35	25 cts.	$114,463
2	5.00	5.00	5.00	3.65	2 25	15.00	13.00	15.00	16.00	6.00	7.00	30	20 cts.	91,570
3	6 00	3.75	1.75	3.25	2.84	13.25	13.50	14.25	14.80	7.50	8.25	35	40 cts.	86,129
4	3.50	3.25	3.75	2.90	2 70	15.95	15.50	17.35	18.35	8.00	10.00	40	37 cts.	84,521
5	5.00	3.25	3.25	3.40	3.30	13.50	14.50	15.00	17.00	6.50	7.50	35	35 cts.	83,921
6	5.54	4 00	1.45	2.11	2.05	13.00	16.00	16.00	18.00	5.00	6.00	25	18 cts.	81,016
7	5.00	3.25	1.25	1.95	1.95	16.00	16.00	17.00	17.00	7.00	8.00	35	20 cts.	79,633
8	4.50	3.00	1.75	2.25	2.00	14.00	14.50	15.50	16.50	5.70	7.00	35	20 cts.	74,190
9	5.00	2.50	2.00	1.60	1.50	12.75	15.00	15.00	17.00	6.00	7.00	35	25 cts.	69,345
10	7.00	3.50	1.00	1.85	1.25	12.00	12.00	14 00	14.00	5 00	6.00	35	15 cts.	68,950
11	5.50	2.40	1.30	1.68	1.50	13.40	14.00	15.60	15.80	5.50	7.50	30	25 cts.	68,718
12	5.28	2.40	1.24	1.08	1.55	12.60	13.25	14.25	15.25	6.60	7.00	34	20 cts.	67 467
13	4.00	2.20	1.10	1.80	2.00	13.00	11.00	14.00	15.00	6.00	8.00	35	25 cts.	65,209
14	3.95	2.45	1.15	1.95	1.39	13.65	13.95	13.45	15.75	6.50	8.25	40	20 cts.	65,153

Wilmette, Ill.—The following bids have been received for a system of sewers in this village: The Evanston Co., C. J. Bartlett, Man., $26,264 for contract No. 1, and $192,700 for contract No. 2; Cook & McDougal, $27,119 and $204,620; C. E. Loss, $30,069 and $206,389; Netterstrom & Bairstow, $30,501 and $202,245; T. D. Murphy, $191,745 for contract No. 2; Thos. Nash, $34,549 and $303,754; Hoban & Lister, $26,800 and $230,367; Delaney, Paddock & Ryan, $204,780 for contract No. 2. The lowest bid for contract No. 1 was that of The Evanston Co., as follows: 54-in. sewer, 800 lin. ft., 18-ft. cut, $7.50 per lin. ft.; 48-in., 500 ft., 17-ft. cut, $6.50; 42-in., 400 ft., 15.5-ft. cut, $5.50; 36-in., 410 ft., 14-ft. cut, $5; 30-in., 510 ft., 14-ft. cut, $4; 24-in., 1,560 ft., 14-ft. cut, $2.50; 24-in., 1,210 ft., 11-ft. cut, $2.40; 12 manholes, complete, $30 each; 13 combined manholes and catch basins, complete, $120; 1 bulkhead and outfall, with 100 ft. of 30-in. wrought iron pipe, complete, $2,000. The lowest bid for contract No. 2 was that of T. D. Murphy, the prices ranging as follows: 18-in. sewer, $1.00 to $2.25 per lin. ft., according to depth of cut; 15-in., $1.00 to $1.83; 12-in., 90 cts. to $1.50; 10-in., $1.19 to $1.33; 9-in., $1.25; 323 manholes, complete, $10 each; 321 combined manholes and catchbasins, complete $30. The soil is blue clay and hard pan. Alexander & Hill, Village Engrs.

STREET WORK.—Lake Forest, Ill.—The lowest bids for the improvement of a system of streets at this place were those of the Talbot Paving Co., as follows: Wood curb, 21,640 lin. ft., 18 cts. per lin. ft.; brick culvert, 300 lin. ft., 50 cts.; grading, 10,820 cu. yds., 30 cts. per cu. yd.; 4-in. drain tile, 21,640 lin. ft., 5 cts. per lin. ft.; 24-in. culvert pipe, 50 lin. ft., 25 cts.; 6-in. foundation, 21,640 sq. ys., 50 cts. per sq. yd. for stone, or 35 cts. for slag; cedar block paving, 21,640 sq. yds., $1 per sq. yd. for common, or $1.20 for sapless blocks. Alexander & Hill, Engrs.

CEMENT.—Los Angeles, Cal.—The following bids were received for furnishing cement for the outfall sewer: Spreckles Com'l Co., San Diego, Cal., 9,100 bbls., to be delivered at Inglewood, at $2.80 per bbl., and 2,900 bbls. at Park Station, $2.85 per bbl., to be shipped within 60 days from date; or 9,100 bbls. at $2.90 per bbl. at Inglewood, and 2,900 at $2.95 per bbl. at Park Station, to be shipped before July 1 next.

Childs & Walton, Los Angeles, Cal., 9,100 bbls. at Inglewood Station, $3.19 per bbl., and 2,900 bbls. at Park Station, $3.27 per bbl.; 1,000 bbls. to be delivered in December, 1892, balance to be delivered 2,500 bbls. or more each month thereafter until the complete delivery is made.

WATER-WORKS.—Fort Myer, Va.—Col. G. H. Weeks has awarded the contract for a water-works system at this place to Jas. L. Parsons at the following prices: 6-in pipe laid, 85 cts. per lin. ft.; 4-in., 53 cts.; brick work, laid, $22 per M; manhole covers, in place, $5.50 each; concrete for 6-in. pipe, $8 per cu. yd.; cisterns, $1,330; pump and boiler house, $1,129; 6-in. terra cotta pipe, 25 cts. per lin. ft.; 8-in., 30 cts.; 10-in., 35 cts.; rock filling, 34 cts. per cu. yd.; total, $10,216.

Wilmette, Ill.—The lowest bid for the construction of a system of water mains was that of J. W. Newcomer, Cleveland, O., as follows: 8-in. main, 34,680 lin. ft., 97 cts. per lin. ft.; 6-in., 90,680 lin. ft., 76 cts.; 218 hydrants, with connection, $34 each; 8-in. stop valves, with connections, 24, $22.60 each; 6-in., 101, $14,60; 6-in. meters, 2, $540 each; 218 hydrant manholes, complete, $20 each; 125 stop valve manholes, complete, $9; 2 special manholes, complete, $25 each. Alexander & Hill, Village Engrs.

PUMPING ENGINE.—Martin's Ferry, O.—The Water-Works Trustees have awarded the contract for a 2,000,000-gallon vertical duplex compound non-condensing pumping engine to the Hughes Steam Pump Co., Cleveland, O., at $12,900. The bids were as follows:

Bidders.	Boilers. HP.	Boilers. Size.	Engines. H. p. Cyl.	Engines. L. p. Cyl.	Pumps. Style.	Pumps. Size of Plunger.	Price.
Wilson-Snyder Mfg. Co., Pittsburg, Pa.	100	66 ins. × 16 ft.	18½ ins.	30 ins.	Differential.	14 and 20 × 30	$12,686
Wilson-Snyder Mfg. Co., Pittsburg, Pa.	100	66 ins. × 16 ft.	18½ ins.	30 ins.	Differential.	14 and 20 × 24	11,426
Wilson-Snyder Mfg. Co., Pittsburg, Pa.	100	66 ins. × 16 ft.	18½ ins.	30 ins.	Double Acting.	14 × 30	13, 675
Wilson-Snyder Mfg. Co., Pittsburg, Pa.	100	66 ins. × 16 ft.	18½ ins.	30 ins.	Double Acting.	14 × 24	12,415
Gordon Steam Pump Co., Hamilton, O.	175	78 ins. × 18 ft.	19½ ins.	34 ins.	Differential.	14 and 20 × 24	12,550
Gordon Steam Pump Co., Hamilton, O.	175	78 ins. × 18 ft.	19½ ins.	34 ins.	Double Acting.	14 × 24	12,550
Hughes Steam Pump Co., Cleveland, O.	175	78 ins. × 18 ft.	20 ins.	32 ins.	Differential.	14 and 20 × 36	12,900

MISCELLANEOUS.

BOILER SETTING AND SMOKE PREVENTING DEVICE, Cleveland, O.—The Board of Control will receive bids until Nov. 30 for setting three tubular boilers, 8 ft. 6 ins. in diameter and 16 ft. long, and equipping them in complete working order with some mechanical stoker or smoke preventing device guaranteed to work perfectly so that the chimney will be practically smokeless, emitting gases not darker than a dull gray. Bids will also be received for equipping three tubular boilers, 8 ft. diameter and 16 ft. long, now in place, with some smoke preventing device, similar to above. Plans and specifications may be seen at the office of the Superintendent of Water-Works.

ENGINES, ELEVATORS, ETC.—Cincinnati, O.—The Board of Directors of the Odd Fellows' Temple Co. will receive bids until Nov. 30 for engines, boilers, tanks, elevators, dynamos, steam heating, pump, etc. Samuel Hannaford & Sons, Architects, Hulbert Block.

BREAKWATER.—Buffalo, N. Y.—Maj. E. H. Ruffner opened bids Nov. 15 for extension of breakwater, and for building 1,600 ft. of the shore arm of Buffalo Harbor. The contracts were awarded as follows: Ira Farnsworth, Lockport, for 32 cribs, 800 ft. of breakwater, total of bid, $94,068; J. J. Churchyard, Buffalo, $107,068.

SEWER PIPE, ETC.—Toronto, Ont.—The City Engineer will receive bids until Nov. 29 for the following supplies for the year ending Dec. 31, 1893: Sewer pipe, ironwork, lumber, crossing stone, lake stone, pressed spikes, wire nails, gravel, loam and sand.

LEVEE.—Vicksburg, Miss.—The Board of Supervisors of Warren Co., will receive bids until Dec. 5 for a levee on the front of Oak Bend and Espero plantations.

GAS COMPANY.—Media, Pa.—The Providence Gas Co. has been incorporated to supply gas to residents of this place; capital stock, $1,000; Henry V. Massey, Philadelphia.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Schenectady Locomotive Works, Schenectady, N. Y., have an order for ten switching engines for the Cleveland, Cincinnati, Chicago & St. Louis. The Richmond Locomotive Works, Richmond, Va., have an order for 25 engines for the Baltimore & Ohio, and are delivering 30 freight engines to the Cleveland, Cincinnati, Chicago & St. Louis. The Rogers Locomotive Works, Paterson, N. J., are building two simple Forney tank engines for suburban service. The Baldwin Locomotive Works have orders for 60 engines for the Baltimore & Ohio, and 2 passenger and 2 freight engines for the Georgia Central. The Canadian Pacific has built 3 mogul passenger engines at its shops at Montreal, Que. The Ocean Springs Lumber Co., of Ocean Springs, Miss., will purchase a logging engine, with cylinders 10 × 16 ins.; Pres. Parker Earle. The Baltimore & Ohio has placed orders for about 75 engines, and is said to be preparing to let contracts for 25 more engines; representing a total outlay of $750,000; the number includes two classes of high speed passenger engines, and one class of heavy freight engines; the company's shops will be run to their full capacity during the winter.

CARS.—The Gilbert Car Mfg. Co., Troy, N. Y., has orders for 60 standard passenger cars, and 40 vestibuled cars on six-wheel trucks, for the New York Central. The Youngstown Car Works, Youngstown, O., have an order for 100 coal cars, with air brakes, for the Lake Shore & Michigan Southern, and is building freight cars for the Erie. The St. Charles Car Co., St. Charles, Mo., is building 30 passenger cars for the Missouri Pacific and 30 for the Wabash; they are heated by steam and lighted by gas. The St. Louis Car Co., St. Louis, Mo., has orders for 100 electric cars, each fitted with two Westinghouse 30-HP. motors, for the Atlantic Avenue road, Brooklyn, N. Y. The James River Coal Co., Huguenot, Va., will purchase 50 mine cars of 2-ft. gage. The Georgia Central has placed orders for 700 freight cars. The Duluth & Iron Range will place orders for 500 ore cars, 22 ft. long and 8 ft. wide, fitted with brakes on each truck. The Philadelphia & Reading will add a large number of freight cars to its equipment. The Baltimore & Ohio will place orders for 2,000 box cars and 500 gondola coal cars; they will be 36 ft. long and of 70,000 lbs. capacity.

LOCOMOTIVE AND CAR SHOPS.—The Philadelphia & Reading is said to intend to erect extensive repair shops for locomotives and cars at Wayne Junction, Pa.

BRAKE BEAMS.—The American Brake Beam Co. has been organized as a consolidation of the Schoen Pressed Steel Brake Beam Co., Pittsburg, Pa.; the Universal Brake Beam Co., St. Louis, Mo.; the Michigan Railway Supply Co., Detroit, Mich, and the Northwestern Railway Supply Co., of Chicago. Pres., H. W. Oliver, Pittsburg, Pa.; capital stock, $2,500,000.

STEEL TIES.—The Philadelphia & Reading will put down 200 Price ties, manufactured by the Price Railway Appliance Co., Philadelphia, Pa.

LIGHT STEAM ROLLERS.—The O. S. Kelly Co., Springfield, O., manufactures a light pattern of roller for new asphalt paving, gravel walks, race tracks, etc. The 5-ton roller has a 48-in. driving wheel or roller, driven by bevel gearing, and two 32-in. steering wheels, each with 40-in face. The ordinary working weight is 11,000 lbs., but by filling the drum of the driving wheel with water or sand, the weight can be increased to 12,000 or 14,000 lbs. The pressure per sq. in. thus ranges from 190 lbs. to 265 lbs. The tank and coal capacity are sufficient for four hours' work. The boiler is vertical, 33 ins. diameter and 4 ft. high, with 3.83 sq. ft. grate area, and 101 1¼-in. tubes. The engines have two inverted vertical cylinders 6½ × 6 ins., placed at one side of the boiler, and driving a steel double-throw, balanced crank shaft. The reversing gear can be used expansively. All gearing is made of steel throughout. The extreme height of the machine is 7 ft. 3 ins.; extreme length, 14 ft., and the extreme width 4 ft. 6 ins.

ALUMINUM.—The Illinois Pure Aluminum Co., Lemont, Ill., announces that its new factory will be in operation shortly, and will manufacture cooking utensils among other articles. The company has a complete plant and will make ingots, sheets, bars, rods, wire, castings and manufactured aluminum articles of all kinds. The company is successor to the Cincinnati Pure Aluminum Co. Pres., Jos. Gerhart; Vice-Pres., H. S. Norton; Gen. Man., J. C. Ashton; Supt., E. Doughman.

THE WESTINGHOUSE ELECTRIC & MFG. CO., has opened its new machine shop in Allegheny, Pa., the old air-brake works having been secured for this purpose, and the equipment of them pushed vigorously. All the apparatus for the World's Columbian Exposition will be manufactured here, and all heavy work, including large generators up to 1,000 HP., and dynamos up to 10,000 16-c. p., capacity. The shops have been equipped with special tools, many of which will be run by electric motors and electric crane. About 500 men will be employed at first.

NEW COMPANIES.—Dunkirk Engineering Co., Dunkirk, N. Y.; $50,000; to manufacture locomotives, boilers, engines, etc.; George M. Newton and Wm. Bookstaver, of Dunkirk, N. Y., and Charles F. White, of Chicago. Young & Willover Automatic Mechanical Railway Block Signal Co., Chicago, Ill; $600,000; G. C. Young, Gordon H. Knott and J. H. Hamilton. Niagara Car Wheel Co., Buffalo, N. Y.; $110,000; George W. Miller and James F. Chard, of Buffalo, and Chester Griswold, of New York. Lyman, Fuller & Post Co., Baltimore, Md.; $10,000; to build roads, railways, water-works, etc.; Arthur W. Lyman, F. W. Feldner and C. W. Buckingham.

CURRENT PRICES.

RAILS.—New York: $30 at eastern mills, $30.75 at tidewater; girder rails, $36 to $39; old rails, $17 for iron, and $14.50 to $15 for steel. Pittsburg: $30; old rails, $20.50 to $20.75 for iron and $15.50 to $15.75 for steel. The rumor that the price of rails is to be reduced to $28 is denied. Chicago: $31 to $32.50; light rails, $32; old rails, $18.50 to $18.75 for iron, and $13 to $14.50 for steel.

TRACK MATERIAL.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.4 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron and steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.75 to 1.8 cts. for iron and steel; spikes, 2 to 2.1 cts. at mill; track bolts, 2.65 to 2.75 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 57½ and 10% and 50%, and 10% on black and galvanized butt welded; 67½% and 10%, and 60% and 10% on black and galvanized lap welded. Casing, 55%.

FOUNDRY PIG IRON.—New York: $13.50 to $15.50. Pittsburg: $13 to $14.25. Chicago: $13.25 to $14.25.

LEAD.—New York: 3.8 to 3.85 cts.; Chicago: 3.72 to 3.75 cts.; St. Louis: 3.6 to 3.65 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.2 to 2.5 cts. for large lots, and 2.35 to 2.75 cts. for small lots; channels, 2.25 to 2.5 cts.; angles, 1.95 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.85 to 2.1 cts.; steel plates, 1.9 to 2 cts. for tank, 2.2 to 2.25 cts. for shell, 2.5 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2.05 to 2.2 cts.; channels, 2.05 to 2.2 cts.; angles, 1.85 to 2 cts.; tees, 2.4 to 2.5 cts.; Z-bars, 2 to 2.05 cts.; universal mill plates, 1.75 to 1.85 cts. for steel; sheared steel bridge plates, 2.1 to 2.25 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.75 to 2 cts. for tank, 2 to 2.25 cts. for shell, 2.1 to 2.35 cts. for flange, 3.5 to 3.75 cts. for firebox, 2.1 to 2.25 for bridge. Chicago: beams, 2.27 to 2.35 cts. for large lots, and 2.5 to 2.75 cts. for small lots; channels, 2.27 to 2.35 cts. for large lots, and 2.45 to 2.75 cts. for small lots; angles, 1.9 to 2 cts. for large lots, and 2 to 2.35 cts. for small lots; tees, 2.2 to 2.8 cts.; universal plates, 2.05 to 2.15 cts.; steel plates, 2.1 to 2.15 cts. for tank, 2.17 to 2.25 cts. for shell, 2.3 to 3.4 cts. for flange, 2.7 to 2.8 cts. for firebox.